THE

Malayan Agricultural Journal.

Edited by the Agricultural Economist with the assistance of
The Publicity Committee.

Vol. XXVIII MARCH, 1940 No. 3.

EDITORIAL 101

ORIGINAL ARTICLES.

RICE STORAGE. R. B. Jagoe, B.SC. 103
THE KIDNEY WORM OF PIGS. T. D. Marsh, N.D.A. 106
FRUIT FLIES. N. C. E. Miller, F.R.E.S., F.Z.S. 112
Sterculia species. A Correction 122

SELECTED ARTICLE

THE STORAGE OF FOODSTUFFS IN THE COLONIAL EMPIRE 123

NOTES AND COMMENTS.

IMPERIAL POLICY ON COLONIAL DEVELOPMENT AND WELFARE 132
SALE OF TEA IN THE UNITED KINGDOM 133
NEW LABORATORIES FOR THE DEPARTMENT OF AGRICULTURE 133
ANNUAL REPORTS OF THE FIELD BRANCH FOR 1938 134
SERANGOON GRASS 134
THE M.A.H.A. MAGAZINE 135
MARKET FOR DERRIS ROOT 135

DEPARTMENTAL.

FROM THE DISTRICTS 136

STATISTICAL.

FERTILIZER PRICES, March, 1940 139
MARKET PRICES, February, 1940 140
MALAYAN AGRICULTURAL EXPORTS, December, 1939 144
MALAYAN PRODUCTION & STOCKS OF PALM OIL & KERNELS, January, 1940 144
AREA OF RUBBER OUT OF TAPPING, January, 1940 145
MALAYAN RUBBER STATISTICS, January, 1940 146
METEOROLOGICAL SUMMARY, January, 1940 147

COMMITTEES OF THE DEPARTMENT

The Advisory Committee.

The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, M.S. (*Chairman*).
The Director, Rubber Research Institute of Malaya.
The Director of Co-operation, F.M.S. and S.S.
The Director of Veterinary Research and Veterinary Adviser, Malaya.
The Chief Research Officer, S.S. and F.M.S.
The Chief Field Officer, S.S. and F.M.S.
Raja Yusuf ibni Almarhum Sultan Abdul Jalil, Raja Muda Perak, O.B.E.
Enche Abdul Aziz bin Ahmad, I.S.M., M.S.C
Mr. Choo Kia Peng, C.B.E., J.P.
Mr. A. C. Smith.
Mr. W. A. Stanton, J.P.
Mr. G. S. Reis, B.Sc (Agric.) J.P.
Mr. C. R. Thurstan, J.P.
Enche Abdul Malek bin Yusof, M.C.S.
Mr. Goh Hock Huat, J.P.
Personal Assistant to the Adviser on Agriculture, (*Secretary*).

Advisory Committee for the Government School of Agriculture, Malaya.

The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, M.S. (*Chairman*).
The Director of Co-operation, F.M.S. and S.S.
The Director, Rubber Research Institute of Malaya.
The Deputy Director of Education, S.S. and Deputy Adviser on Education, M.S.
Mr. W. A. Stanton, J.P.
The Hon'ble Mr. Cheok Huan Cheong, M.S.C.
The Hon'ble Tuan Sheikh Ahmad bin Sheikh Mustapha, M.F.C.
Mr. P. A. Rogers, M.A.
Mr. W. E. Wallis. (*On leave*).
Mr. J. B. Leask.
The Principal, School of Agriculture, (*Secretary*).

Agricultural Pests Supervising Committees.

Under Section 4 of Ordinance No. 166 (Agricultural Pests) and Section 4 of the Agricultural Pests Enactment there is an Agricultural Pests Supervising Committee in the Straits Settlements and in each of the Federated Malay States of which the Director of Agriculture is a member.

The Publicity Committee.

The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, M.S. (*Chairman*).
The Chief Field Officer.
The Chief Research Officer.
The Agricultural Economist (*Secretary*).

Inter-Departmental Propaganda and Marketing Committee.

The Director of Co-operation (*Chairman*).
The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, M.S.
The Director, Rubber Research Institute of Malaya.
The Director of Veterinary Research and Veterinary Adviser, Malaya.
The Assistant Director of Co-operation, South.
The Assistant Director of Co-operation, North.
The Chief Field Officer, S.S. and F.M.S.
The Agricultural Economist, S.S. and F.M.S.
The Personal Assistant to the Director, Rubber Research Institute of Malaya.

THE

Malayan Agricultural Journal.

MARCH, 1940

EDITORIAL.

Control of Pests.

It has been said, somewhat facetiously, that only two problems cause concern to the agriculturist in Malaya: keeping the crop alive during droughts, or preventing it from being washed away by torrential rains, and that when climatic conditions are ideal the crop will flourish only to be rapidly devoured by insects. This somewhat gloomy view of agriculture may contain a germ of truth as representing the disappointments upon which farmers and planters flourish the world over, but it is now widely realized that very extensive losses are experienced through the ravages of insect pests. Precautions can be taken to minimize loss through climatic conditions; seasons of planting are chosen, protection is given to the young plants, the moisture in the soil is conserved by cultural methods—in fact the main practices of agriculture are evolved around expected climatic conditions.

The losses to agriculture through pests are usually more insidious and more recurring than losses from any other one cause, and for this reason the agriculturist himself is frequently blissfully unaware of his loss. But even if the loss to the individual be small, the ravages of pests can become so widespread as to cause serious loss to the country.

The above remarks are prompted by the inclusion in this number of articles which deal with one aspect or another of insect pests. Reference is made in these articles to the insect pests of stored rice, to flies which attack fruit, and to a parasitic worm of pigs. The subjects dealt with are of more than passing interest in Malaya, for they concern agricultural products of particular importance to this country. Readers will require no reminder of the added importance of the cultivation and storage of food in Malaya during the present war period; it behoves those concerned, therefore, to protect their crops and livestock from loss due to preventable causes such as are here considered.

We would emphasize that stock and crops may be protected from the pests considered in the following pages. Although the nature of the pests considered in these three articles is very different, there is one point of similarity between them,

viz. that control aims at the protection of the host against the introduction of the pest, and this control is obtained by precautions to ensure the greatest possible degree of cleanliness.

The control of a pest which has already invaded the host is very frequently expensive, whereas methods to ensure cleanliness and thus prevent the introduction of the pest are usually inexpensive, but necessitate very close personal supervision. We would urge, therefore, that those responsible should insist on recommended and generally well-known precautions for the protection of their crops and livestock against pests, and would remind them that they must be unremitting in their vigilance to ensure success to this end.

Original Articles.

RICE STORAGE

BY

R. B. JAGOE,

Botanist.

Storage of rice has become a matter of considerable importance in the present emergency and much larger stocks are now being kept for longer periods than usual by many employers and large institutions.

The Department of Agriculture has storage experiments in progress, but these will not be completed for some months.

It is apparent to officers of the Department engaged in these experiments that many managers of estates and mines and others in charge of large institutions, where fairly large stocks of rice are now being kept, have not had an opportunity to realize the essential factors associated with the satisfactory storage of this commodity.

This brief note may, therefore, assist in providing information which will help towards the avoidance of waste caused by bad conditions of storage, which are especially significant when stocks are kept for more than about two months.

A most important matter is that the rice should be as dry and clean and as free from insects as possible before storage. A moisture content of less than 12 per cent. is essential, preferably it should be under 10 per cent. Rice which is milled from unstored fresh padi and which contains a much higher percentage of moisture will not keep for more than 5 or 6 weeks.

Another important point, not only in preventing normal deterioration of rice but in preventing also serious infestation by weevils and other insects, is that low air humidity and low moisture content of rice should be maintained. A low humidity will not only preserve the rice from becoming mouldy but will greatly retard or inhibit the breeding of insect pests. A simple form of air-conditioning or air-dehumidifying plant would be necessary to effect this but the problem of expense precludes its use for this purpose; efficient ventilation is therefore the only alternative.

Other important considerations for storage of rice are protection against rats and birds and the arrangement of the sacks so that they are not in contact with stone or metal.

The following are general recommendations for a rice store:

(i) The site, as far as practicable, should be dry and cool.

(ii) The ideal building is probably one with thick wooden walls, but ordinarily the building may be of wood or brick.

(iii) An insulating cool roof, overhanging if possible, is valuable, especially if natural shade is not available.

(iv) The sacks of rice should be raised off the floor at least 6 ins. on dry planks. Even if the floor is of wood, the better ventilation and greater degree of cleanliness thus achieved are most valuable.

(v) The most satisfactory method of stacking the sacks is to arrange them suitably in double rows. This allows of good air movement between the sacks. The space between the sacks need not be wider than 1 ft.; it will depend on the space available and ease of handling the sacks.

(vi) The sacks should not be in contact with metal or stone, as the high or relatively high conductivity of these materials induces condensation of moisture, which will cause rotting of the sacking material.

(vii) Ventilation is important. If possible, windows both on the sides and at the ends of the building should be provided. Space should be left at the top of the walls to give optimum ventilation. The windows may be set as low in the building as is conveniently possible. They should be closed during rain and mist, otherwise they should be kept open regularly.

(viii) The store should be protected with expanded metal and/or fine mesh wire-netting against entry of rats and birds, both on windows and wall-top ventilation space.

(ix) Crevices should be avoided in the construction or conditioning of the store. The caterpillars of several species of moths which infest rice leave it to pupate, seeking for crevices and cracks in the walls for this purpose.

(x) White-washing the building inside will show up insects and dust. This helps to keep a building clean and often aids in early detection of insects.

(xi) Whenever possible care should be taken to empty the store entirely and to clean it thoroughly.

While it is considered that a store constructed according to the above recommendations will normally maintain good rice in sound condition for a reasonable length of time, say 5 to 6 months, there is the possibility that insects may gain entry and infest the rice. An ideal store, therefore, should provide for the exclusion of insects.

Wire-gauze, however, is both expensive and somewhat easily damaged. Moreover, protection against insects by this means is not usually a major consideration for storage of rice up to 5 months, for, if other conditions of storage are not suitable, insect larvae, normally already in the rice, will multiply and do great damage in addition to the direct deterioration of the rice, by reason of the high humidity.

The further protection, therefore, against insects by wire-gauze on windows and wall top ventilation space may be an ideal additional precaution, but for short storage, it is not as essential as good ventilation. If the store is, however, too near an obvious source of infection, such as a padi mill or rice shops, insect proofing will probably repay, but it is usually possible to arrange for the store to be sited away from such sources of infestation.

Insect proofing will probably repay in any circumstances if storage for periods over 5 or 6 months is contemplated.

Where sufficiently good conditions of storage to prevent early serious infestation of insects are not possible, the provision of some means whereby fumigation may be carried out would be an advantage. The advice of the Department should be sought in this connexion.

It may not be possible to put all these recommendations into effect in all circumstances but the advice of this Department will be given readily on any occasion if required.

Received for publication, 10th February, 1940.

THE KIDNEY WORM OF PIGS, *STEPHANURUS DENTATUS* DEISING, 1839

BY
T. D. MARSH,
Senior Agriculturist.

Introductory.

The most serious helminth pest affecting adult swine in Malaya is probably *Stephanurus dentatus,* commonly known as "The Kidney Worm of Pigs," which is a parasite of tropical and sub-tropical climates.

Extensive research has been carried out on this pest in Australia and the sub-tropical regions of the United States of America(1 & 2). Further reference will be made to the research work carried out in Australia.

The Veterinary Department in Malaya has collaborated in the collection and microscopic examination of pig urine specimens from the Central Experiment Station, Serdang, and other Agricultural Stations which were essential to the present investigation.

Observations in the larger Malayan abattoirs indicate the incidence of attack and the degree of infestation to be more marked in the case of European breeds and their cross-breds, and the same degree of infestation causes such animals more distress than pure-bred Chinese pigs.

No anthelmintic is known that will eradicate the worms from the kidneys. Chinese pig-keepers have a firm belief that cooked banana stems have a definite action in checking the ravages of this pest or ameliorating its effects on infested animals, and it is a recognized practice among Chinese pig-keepers to include the above constituent in the animals' ration. Arrangments are being made to carry out experiments on these lines at Serdang. Prophylactic measures, however, are the most reliable means of suppressing the spread of this pest throughout a herd.

Description of Worm and Method of Infestation.

The adult worm is mottled in colour, varies from 1 to 2 ins. in length and is about 1/16th in. thick.

Adult animals infested with this worm void the eggs in their urine. The eggs hatch and the newly-hatched larvae gain access to the body either through the mouth and alimentary tract or through the skin.

The larvae entering *via* the alimentary tract usually pass up the bile duct to the liver and the young worms bore their way through the tissues of this organ forming cysts and lesions. It is reported by investigators(2) that very few of the worms passing through the liver tissues reach the kidneys. In the case of skin penetration the young worms bore their way through the abdominal and thoracic tissues causing a general derangement of these organs. Some of the worms eventually reach the kidneys and are able to carry on the life cycle of the parasite by the excretion of the eggs in the urine.

The worms cause severe unthriftiness, weakness and paralysis of the hind quarters and, on occasions, death owing to kidney disease or the occlusion of the portal vein and the development of colic. Probably the most serious pathological effect is the insidious derangement of the functioning of the liver.

Only those worms reaching the kidney are able to carry on the life cycle of the parasite as a result of the excretion of eggs in the urine.

Summary of Research Work in Australia.

An abridged summary of the results of investigations carried out on this pest in Australia is given below. This summary has been abstracted from Bulletin No. 58, 1932, published by the Council for Scientific and Industrial Research, Commonwealth of Australia.

Distribution and Economic Importance.

(a) *S. dentatus* is well established on the eastern coast of Australia, from Sydney northwards, but is unknown, or very rare, in the Southern States, and in the southern part of Western Australia.

(b) At certain abattoirs in Queensland, the incidence of infestation is as high as 70 per cent. of all pigs killed, while at some centres on the north coast of New South Wales a similar incidence occurs.

(c) Infestation may be of great pathogenic importance, principally due to the lesions produced in the liver by the immature worms rather than to the effects of the adult worms in the peri-ureteral tissues.

(d) The parasite is also of great economic importance, because heavy infestation not infrequently leads to total condemnation of the carcase, while even moderate infestation may lead to rejection of the carcase for export to Europe.

Pre-parasitic Stages in the Life-Cycle.

(a) The egg usually hatches in 24 to 36 hours at an optimum temperature of 77° to 81° F. The larva undergoes two metamorphoses before reaching the third or infective stage, after 95 to 120 hours at the optimum temperature mentioned above. No eggs survive exposure at a temperature of 43° to 46° F. for more than 2 days.

(b) Infective larvae may remain alive in soil and faeces media for periods up to 154 days, but those surviving decrease very markedly after 108 days. In liquid media, few survive beyond the 50th day.

(c) Both eggs and larvae are extremely susceptible to desiccation in shade or sunshine. No eggs survive shade desiccation in a thin layer of mud for more than 1 hour, while infective larvae unprotected on glass are killed by shade desiccation for 1 hour. When mixed with mud up to about 2 ins. depth, however, larvae are capable of surviving some days in apparently dry mud. In sand, death takes place more rapidly than in mud, owing to the faster desiccation.

(d) Larvae show a tendency to migrate from superficial situations to deeper mud, but not to migrate to the surface from deeper situations.

(e) Both eggs and larvae in water are killed by the action of the following drugs in 1 in 1,000 solutions in 24 hours or less, cyllin,* kerol,† copper sulphate, mercuric chloride.

(f) Where larvae were intimately mixed with mud of limited depth (half an inch) it was found that they could all be killed by spraying with 10 gallons of a 10 per

* A proprietary preparation having a phenolic base.

† Kerol is a proprietary preparation stated to be non-toxic. It is recorded as containing 40 per cent. of "tar acids" (phenols and cresols.)

cent. solution of copper sulphate or of a 5 per cent. solution of kerol per 100 sq. yds. The latter solution remained highly toxic for larvae added to mud which had been treated with it 66 days previously. Both solutions proved non-toxic for pigs shut in treated yards.

Parasitic Stages in the Life-Cycle.

(a) Infestation may be brought about *via* the alimentary tract, or the intact skin.
(b) It is considered that migrating larvae and immature worms normally progress by direct penetration of the tissues rather than by way of the blood or lymph streams, though frequently larvae enter the lymph stream and become arrested in lymph glands.
(c) Following skin infestation, striking skin lesions characterized by nodule formation, oedema, and enlargement of superficial lymph glands are seen from the 4th day onward, these increasing in prominence for 17 to 20 days, and then decreasing gradually until about the 30th day.

Control and Eradication.

(a) All moist muddy areas contaminated with urine and faeces are grave sources of danger. These are most frequently found under shade trees, around feed-troughs and hog wallows, and in any depression where water accumulates and remains.
(b) Every effort should be made to eliminate permanent muddy areas by drainage, or by filling in depressions, and by installing raised hygienic feed troughs and concrete wallows. Where it is impossible to eliminate all muddy areas, if not extensive these should be sprayed with kerol at the rate of 10 gallons of a 5 per cent. solution per 100 sq. yds.
(c) Farrowing pens and yards used for young pigs should be unstocked periodically and allowed to become thoroughly dry in sunlight for at least a fortnight, or should have damp areas sprayed with kerol.
(d) Complete eradication may be effected, where pigs are run in yards, by suitable sub-division and segregation of infested stock from clean stock, in the manner suggested.
(e) Young clean pigs may be reared by old infested sows so long as the latter are confined to well-drained and floored pens, while the piglings alone have access to clean earth yards.
(f) All young pigs as weaned, should be placed in previously unstocked yards, or yards which have been unstocked for 5 months* if damp or which have been desiccated in bright sunlight or sprayed with kerol.

Incidence of Disease in Malaya.

As previously mentioned, observations in the larger Malayan abattoirs indicate a greater degree of infestation with animals of European breeds and their cross-breds (European x Chinese) than with pure-bred Chinese pigs. It has been suggested that this may be due to the European and the cross-bred pig having a finer skin, thus facilitating infestation in this manner. On the other hand, it may be due to the generally recognized greater degree of resistance found with the locally-bred compared with the imported animal.

With regard to the distribution of the disease in Malaya it is interesting to note that it does not occur in pigs bred at the Agricultural Station at Cameron Highlands.

* The Director of Veterinary Research and Veterinary Adviser, Malaya, advocates a period of 6 months for this country.

The Tanah Rata Station is situated at an altitude of 4,750 ft. above sea level, the average minimum temperature being about 56°F. This temperature appears to be sufficiently low to inhibit the development of the larvae during the 4 to 5 days when the life cycle is continued outside the host's body, since negative results have always been obtained in tests of urine taken from pigs bred at this Station, even though the original stud stock which were supplied from Stations on the Lowlands are known to have been infested.

In a trial at Serdang, pigs bred from heavily infested parents were reared free of the parasite by spraying the concrete floor of the stye with a 10 per cent. solution of copper sulphate every third day until the litter was weaned. The weaners were removed to an open pen to which pigs had not had access for several years. When the pigs were slaughtered at 10½ months of age the carcases were pronounced by the Veterinary Officer at the abattoirs to be free of the parasite.

Housing of Pigs.

The open range system of pig keeping with a shelter shed as a protection against inclement weather usually adopted on farms in temperate climates is unsuited to Malayan conditions owing to the much heavier annual rainfall. The latter, even during the dry seasons, will maintain the ground sufficiently damp to provide a suitable medium in which the larvae can exist.

The use of an exercise yard of limited accommodation will result in a concentration of the larvae over the whole yard on or just below the surface. Large fields are less dangerous, although heavy contamination of the ground in the vicinity of the entrance to the field and of the feeding troughs is likely to occur by reason of the habit of the pigs to congregate and urinate in such places.

The construction in the field of one or more concrete floors, with surrounding drains, on which feeding troughs can be fixed lessens the danger, especially if floors not in use are railed off and left exposed to the sun. At the same time the writer considers that pigs should be kept in confined spaces or styes and on floors which can be maintained in a clean condition.

Following Australian practice concrete as a flooring material would appear to be indicated, although slatted floors merit consideration.

Slatted Floors.

This form of construction, which is popular among poultry keepers, consists of battens spaced some distance apart to permit urine and faeces to fall through the floor. Ventilation of the enclosure is also improved.

As far as pigs are concerned such floors are already widely used by Chinese pig-keepers on low-lying areas, particularly in the flat coastal districts.

The floors are usually constructed about 2 ft. above ground level, using split trunks of the nibong palm (*Oncosperma tigillaria*) laid with the round side upwards. Hardwood battens 3 to 4 ins. wide with the upper surface rounded would probably be equally suitable. The slats must be firmly fastened down about ¾ to 1 in. apart to joists triangular in section, or with the upper surface between the slats bevelled, thereby preventing urine and faeces from lodging on the joists between the slats. A sloping concrete floor with a drain at the lower end leading to a manure pit should be constructed below the slatted floor at ground level.

There seems little doubt that the Chinese custom of adopting this form of construction in damp situations and in the flat coastal areas has a fundamental bearing on the comparatively low rate of infestation among animals reared on these floors.

The value of a slatted floor will be appreciated when it is remembered that the eggs of the parasite are being continuously voided in the urine of infested animals from the age of about 7 months onwards. Since newly-hatched larvae require from 4 to 5 days to become infective, the custom of constantly sluicing slatted-floored styes and the animals therein with copious amounts of water washes all eggs away through the slats, thereby preventing infestation of the host.

Concrete Floors.

Although on theoretical grounds a slatted floor is preferable to a concrete floor, the slatted type is apt to present difficulties in construction to provide a floor sufficiently strong to withstand the persistent uprooting proclivities of housed pigs. Concrete flooring is, therefore, considered a more practical form of construction. Attention should be paid to the following points when using this type of flooring:

(*a*) The styes must be sufficiently large to prevent overcrowding, otherwise the animals will relieve themselves promiscuously. If each pen consists of a double compartment, one for sleeping with a slightly raised floor and the other for feeding and exercise, the animals will not normally foul their sleeping quarters.

(*b*) The floor should be finished with a hard smooth sand-cement rendering and the surface grooved diagonally to furnish a quick run-off of urine and sluicing water.

(*c*) A vertical fall of 1 in. to 48 ins. horizontal should be arranged when laying the floor, instead of the usual 1 in. to 100 ins. allowed with floors of cattle sheds and pig styes; the increased degree of slope should not inconvenience the animals.

(*d*) The feeding and exercise yard should not be covered by a roof or shaded by trees. Research work in Australia shows that sunlight is an important agent in destroying the eggs and larvae of this pest.

(*e*) Daily cleansing of the styes with a stiff broom followed by a vigorous sluicing of water is desirable.

Food and Water Supplies.

The manure drawn from a sump adjacent to the styes may also be a source of infection if applied to crops used for feeding to the animals. As previously mentioned, the larvae can live in damp and shaded situations for periods exceeding 5 months, and are therefore liable to be transferred, adhering to uncooked foods, to the animals in the styes.

Any foodstuffs to which such manure has been applied should be cooked before being given to the animals, irrespective of whether the foodstuff contains a cyanogenetic glucoside([3]).

In this connexion attention must be drawn to the question of the destruction of the vitamins contained in the fresh material as a result of the boiling process. To make up for the deficiency in this respect a small proportion of young fresh

fodder grass should be included in the ration of all animals kept in confined spaces. The grass should be grown on land not treated with pig manure(3).

Care should also be taken to ensure that the water supply for the animals is not polluted as a result of contamination with liquid manure. No well or water-hole should be sited in the vicinity of the manure pit. If the source of the water supply is a stream, similar precautions should be taken to ensure the absence of contamination with pig manure above the place from which the supply is drawn.

The practice of cutting a hole in the wall of the farrowing pen through which the suckling pigs can pass to roam should be avoided. If the sow is infested the piglings disseminate on their hoofs the eggs and larvae; alternatively, if the parasite is present in the earth on the holding the piglings are exposed to infestation.

Since about six months elapse from the first ingestion of larvae to the excretion of eggs, it will be realized that the breeding animals in a herd are most likely to disseminate the parasite. Fatteners, infested when very young, under a system of modern rapid feeding should be approaching slaughter weights when they commence to void eggs.

Conclusions.

It is considered that by the use of confined spaces kept scrupulously clean by sluicing with fresh water from an uncontaminated source and adopting the precautionary measures recommended regarding the cooking of all succulent foods the spread of the pest can be prevented.

Of the two types of flooring described for the confined spaces slatted floors are the more suitable on theoretical grounds, although concrete is the more practical type and has been adopted at the Stock Farm, Serdang.

The ultimate extermination of the worm is much more difficult in Malaya than in the semi-arid regions of Australia owing to heavy rainfall and continuous damp soil conditions in shaded situations.

Acknowledgment.

The writer wishes to acknowledge the assistance of Captain S. H. Whitworth, Director of Veterinary Research and Veterinary Adviser, Malaya, in the compilation of this article.

References.

1. Clunies Ross, I, and Kauzal, G. The Life Cycle of *Stephanurus dentatus* Deising, 1839. The Kidney Worm of Pigs with Observations on its Economic Importance in Australia and Suggestions for its Control. Commonwealth of Australia Council for Scientific and Industrial Research, Bulletin No. 58, 1932.
2. Hall, M. C. Worm Parasites of Domesticated Animals. Parasites of Swine. Bureau of Animal Industry. U.S. Dept. of Agriculture.
3. Marsh, T. D. Pig Keeping in Malaya. *Malayan Agricultural Journal*, Vol. XXVIII, No. 1, January, 1940, page 3.

Received for publication, 7th February, 1940.

FRUIT FLIES

BY
N. C. E. MILLER,
Entomologist.

Introduction.

Certain flies, generally known as fruit flies, which belong to the family Trypetidae of the Natural Order Diptera or two-winged flies, constitute an important obstacle to the successful cultivation of some kinds of fruits in Malaya and in other parts of the world.

These flies, which are widely distributed throughout the tropics, are represented in Malaya by a good number of species, of which, however, only four or possibly six are definitely known at present to be of economic importance.

From an economic point of view the most important of all fruit flies is the so-called "Mediterranean Fruit Fly" (*Ceratitis capitata* Wied.), an insect which has established itself on every continent except that of North America, but which is probably of African origin.

Fortunately, this pest, which without doubt owes its wide distribution mainly to having been introduced into various countries in infested fruit imported before quarantine organizations were instituted, has not established itself in this country, although the possibility of its having been imported from time to time must not be ruled out.

It is probable that the explanation for its failure to become established in Malaya is that climatic conditions are unsuitable and not that host conditions are unfavourable, since an appreciable number of different kinds of fruits attacked by this species are cultivated in Malaya, and certain fruits are available throughout the year.

In the present paper it is proposed to set forth the available information regarding four species, *Chaetodacus ferrugineus* F., *C. cucurbitae* Coq., *C. caudatus* F., and *C. umbrosus* F., which have been the subject of investigation for the past few years.

It should be borne in mind that fruit flies are essentially primary pests of fruits, and should, therefore, not be confused with certain other flies belonging to the families *Drosophilidae* and *Neriidae* which may always be seen, frequently in large numbers, on decaying fruits. These flies are attracted to fermenting substances, a fact which has earned for the *Drosophilidae*, the name of "vinegar flies," among other common names.

In certain circumstances, however, fruit flies may be secondary pests, for example, in respect of fruits with a thick or tough rind, such as mango, mangosteen, citrus and some kinds of bananas. These fruits are rendered susceptible to attack only when they have been injured by heavy rain or by other causes.

Citrus fruits of the types with thick rinds are liable to attack when they have been damaged by the larvae of the fruit borer *Citripestis sagittiferella* Moore, which cause large areas of decay to form on and under the surface.

General Observations and Descriptions.

As stated in the introduction there are four, possibly six, species of fruit flies which are definitely of economic importance in Malaya. Of one of the four, namely *C. ferrugineus*, the life cycle has been worked out on several occasions.

Breeding fruit flies under laboratory conditions is by no means easy, and it was only after a number of unsuccessful attempts that a method was adopted by which they could be induced to lay eggs. In the preliminary experiments, carambola fruits were supplied, but, even if the skins had been previously punctured so as to provide places in which flies might be encouraged to lay eggs, the results were unsuccessful.

Finally, small slices of papaya and cucumber and a supply of water were provided. Flies then laid eggs freely, and since the portions of fruit were small, the eggs could be located without much trouble. This method is a modification of the technique evolved by Simmonds(1), the difference being that the mixture of fruit juice and water which he placed in his cages was omitted.

The reason for the reluctance of flies in capitivity to lay eggs even in fruits which they readily attack in the field is still not understood.

The kind of fruit supplied for the flies to lay eggs in and also to feed on, would appear to influence the preoviposition period, that is, the period from the emergence of the adult to the time when eggs are laid, this period being somewhat shorter when flies are supplied with cucumber than when papaya is provided.

In Tables I and II details of the life cycle of *C. ferrugineus* are given, and, as will be seen by the figures of the duration of the various stages, an appreciable degree of variation occurs, a variation which does not appear to be influenced by the kind or quality of food provided, since fresh portions, ostensibly of a similar quality, were supplied daily.

The larva moults three times during its life, the first moult taking place 24 hours after hatching and the second moult 24 hours after the first moult. The ensuing period, or the third instar, varies in length.

Investigations are in progress on the other principal species and efforts are being made to obtain as complete a record as possible of fruits, both wild and cultivated which may be attacked by these flies.

The feeding habits and methods of egg-laying of *C. caudatus*, *C. cucurbitae* and *C. umbrosus* are similar to those of *C. ferrugineus*, and the control measures which are recommended for *C. ferrugineus* may be considered to apply to those species.

Before entering into details regarding the species under review it will be appropriate to give a brief description of the structural characters and habits of the Trypetidae.

The eggs are usually cylindrical with each end rounded. Fruits, flowers, galls, stems or leaves of plants are some of the situations in which the flies lay their eggs, but it is probable that fruits are most commonly selected for the purpose. The larvae, or maggots, are cylindrical, tapering towards the head, and somewhat broadly rounded at the posterior end. The mouth consists of two strong hooks by means of which food is obtained by a scraping or raking action.

Table I.

Chaetodacus ferrugineus. F.
Food - Papaya.

Preoviposition Period	Incubation Period	Larval Period	Pupal Period	Sex.
days	days	days	days	
62	1	14	8	male.
60	1	11	8	male & female.
60	1	11	8	male.
64	1	12	8	"
53	1	9	9	female.
49	1	18	9	"
46	1	16	10	"
36	1	12	9	—
36	1	13	8	—
41	1	7	9	—
26	1	12	10	female.
29	1	11	9	male.
43	1	11	9	female.
Food - Cucumber.				
43	1	15	9	male.
65	1	6	8	"
58	1	9	9	female.
43	1	15	10	male.
47	1	15	9	"
30	1	10	9	female.
43 — 48	1	9 — 17	7 — 10	male & female.
17 — 22	1	9 — 15	8 — 9	" " "
42 — 47	1	13 — 14	8 — 9	" " "
52	1	9	7	male.
51 — 52	1	10 — 13	8 — 10	male & female.
36	1	10	8	male & female.
38	1	8	8	male.
37	1	7	9	"
26	1	13	9	female.
36	1	13	9	—
43	1	13	8	male.
47	1	12	8	male & female.
37	1	6	11	female.
30	1	18	6	male.
30	1	9	13	male.
26	1	13	5	female.

At the anterior and posterior ends are situated the spiracles or apertures through which the larva breathes, the anterior pair being different in structure from the posterior pair and apparently are capable of being withdrawn into the body when occasion demands. The posterior spiracles are surrounded by a number of filaments. In aquatic larvae similar filaments are present and are designed to maintain the larva at the surface of the fluid to which it has ascended to replenish its supply of air, and it would seem that they perform a like function in the case of fruit-fly larvae.

Table II.

Chaetodacus ferrugineus.
Food - Papaya.

Preoviposition Period days			Incubation Period days			Larval Period days			Pupal Period days		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
46.5	64	26	1	1	1	12	18	9	8.7	10	8
Food - Cucumber.											
40.5	65	17	1	1	1	11.9	18	6	8.7	13	5

When the larva is full-grown and the time for pupation arrives, it shrinks considerably and finally the skin hardens to form what is known as the puparium. This is cylindrical and rounded at each end, and the fly, in order to emerge from it, causes it to split transversely near the anterior end.

Fruit flies are active insects and may usually be seen actively moving about on leaves and fruits, the females in search of suitable sites for egg laying. The female fruit fly is provided with an extensible ovipositor or egg-laying instrument by means of which it pierces holes through the skin of fruits and inserts its eggs into the tissues.

As a rule, several eggs are laid by one female in a single cavity, but, occasionally, to judge by the extra large number of eggs which have been recorded from one cavity, it is reasonable to infer that more than one female has laid eggs therein.

A period of one day is sufficient for the incubation of the eggs and, as will be seen by the figures in Table I, a comparatively short time elapses before the larva is ready to pupate. By this time the attacked fruit may have prematurely fallen from the tree, but the larvae will not leave it until full grown. They then crawl out and enter the soil into which they penetrate to a depth of about a couple of inches. Should the fruit not have fallen by the time larvae in it have reached maturity, the larvae will not pupate in it but will crawl out and fall to the ground.

On emergence from the puparium, the fly forms a passage through the soil, sometimes taking advantage of tunnels made by other insects, and when it is able to fly, seeks some plant on which there are flowers from which it may obtain food. Fruit flies will also imbibe drops of moisture from leaf surfaces.

A characteristic of fruit fly larvae which is also shared by certain other larvae which are not, however, destroyers of fruit, is the ability to move from place to place by means of a springing movement which is effected by the engagement of the mouth parts with the posterior end of the body. The sudden release and return to a normal position causes the larva to jump away from the spot on which it was lying.

The egg of *C. ferrugineus* is white and shining. In shape it is cylindrical, slightly curved, narrowly rounded at each end and a little constricted at one end. It measures about 1.10 mm. in length. The larva is also white with the exception of the mouth parts which are blackish. When nearly full grown it measures 8 to 10.00 mm. in length and becomes a little darker in colour. The puparium is brownish with the spiracles darker and is about 5.00 mm. in length. (Plate 1. Figs. 1 to 3.)

The adult *C. ferrugineus* has a yellowish head with dark brown areas beneath. In the living flies the eyes are brown or purplish-brown with a faint metallic lustre which disappears after the death of the fly. The thorax is greyish with the anterior lateral angles and raised lateral areas pale yellow, and with two elongate pale yellow stripes near the sides. The scutellum, *i.e.*, the trapeze-shaped area behind the thorax, is pale yellow. The abdomen is dark yellow with blackish areas at the base; segment 2 is paler, and both it and segment 3 have a transverse blackish stripe; from the stripe on segment 3 a longitudinal stripe extends along the middle to the end of the abdomen. Segments 3 and 4 are blackish at the sides. The legs are yellowish, except the posterior tibiae which are blackish.

The wings have a narrow blackish area along part of the outer margin and a faint smoky area near the base of the inner margin. Plate 1. Fig. 4.)

C. ferrugineus has so far been recorded from the fruits of sapodilla, mango, lime, orange, cotton, loofah, papaya, chilli, *Solanum verbascifolium*, rambutan, pomelo, carambola, guava, *Eugenia aquea*, tomato.

The adult of *C. cucurbitae* may be distinguished from *C. ferrugineus* by the smoky spot at the apex of the wings and also near the inner margin. The outer margin of the wings is yellowish with a smoky tinge. *C. caudatus* has clear wings but may be distinguished from *C. ferrugineus* by the four long bristles on the scutellum. *C. umbrosus* may be distinguished from the other three species by the distinct smoky stripes on the wings

C. cucurbitae has been recorded from melon, chilli, cucumber, *Momordica charantia*, wax gourd, *Trichosanthes palmata*, pumpkin, carambola, *Eugenia aquea; C. caudatus* from pumpkin, *Trichosanthes palmata*, wax gourd, tomato, *Eugenia javanica* and *Luffa cylindrica; C. umbrosus* appears to be essentially a pest of the jack fruit and its allies, but further investigations may show that it is not restricted to those fruits.

Control of Fruit Flies.

In the control of fruit flies, as in the control of other kinds of insect pests, it is of the greatest importance to ensure that the area under the crop liable to attack is maintained in as clean a condition as possible and free from wild plants, the fruits of which are liable to be infested by these flies. However, to recommend that alternative host-plants be destroyed, is, it is realized, somewhat of a counsel of perfection, but, in the case of fruit flies, it should not be an insuperable difficulty to locate such plants, either wild or cultivated, which bear fruits suitable for the propagation of these insects and to destroy them.

It is a matter for regret that, very frequently, the main obstacles to be overcome in the control of insect pests are apathy and lack of co-operation, conditions which must certainly nullify efforts made to free cultivated areas from pests, since it is obvious that unless such control measures as may be recommended are assiduously carried out by owners of contiguous properties, the efforts of those who do endeavour to control pests will be largely wasted.

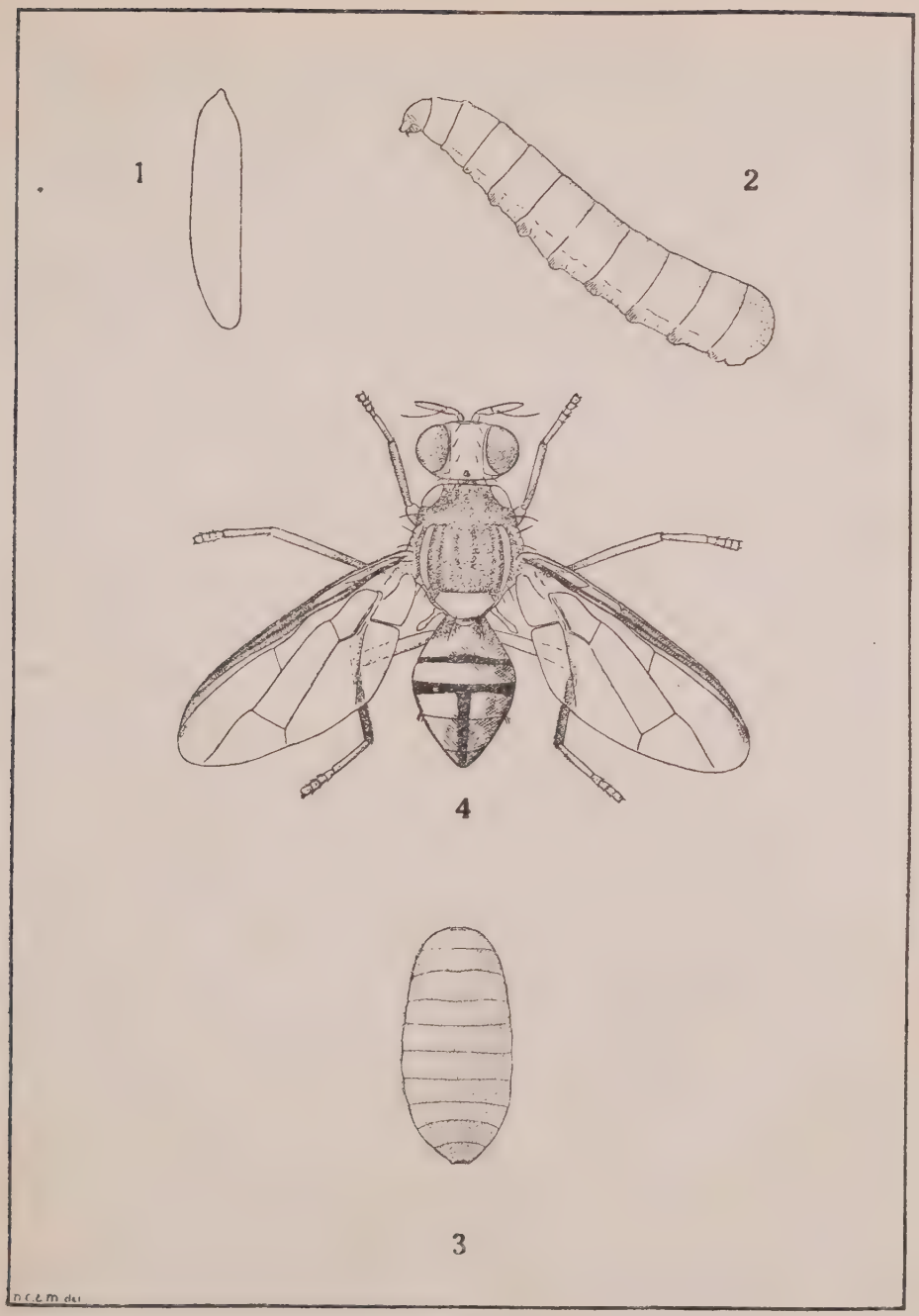

Plate I.

Chaetodacus ferrugineus F.

1. Egg (natural size 1.10 mm). 2. Larva (natural size 10 mm).
3. Puparium („ „ 8 mm). 4. Adult („ „ 7-8 mm).

In other countries where fruit flies are pests, various control measures are practised, these measures comprising the trapping of flies by means of baits and the destruction of infested fruits.

Extensive research has also been carried out on substances which will attract both the male and female flies and which could be used economically as baits on a commercial scale, but it can hardly be said that the efforts expended have been crowned with marked success.

Even when a substance that has shown promise has been found, the fact still remains that its adoption as a control for the flies can be considered as ancillary only to the practice of other methods, such as the protection of sound fruits and the destruction of infested fruits.

Another factor to be considered in control work, which emerges from trials to confirm or otherwise the attractant qualities of various substances, is the discovery that male and female flies are not always equally attracted; in fact it has been demonstrated that certain substances will attract only males. It has also been shown that a substance which is an efficient attractant to a certain species in one country is quite useless for the purpose elsewhere.

In the preliminary investigations described in the present paper, further evidence has been sought on these points and a search has also been prosecuted for other possible attractants, especially substances which are cheap and easily obtainable, factors of paramount importance in a country where fruit growing is mainly a peasant occupation.

Prior to the investigations which are now being carried on, a considerable number of trials of various olfactory substances, some of which were known to be attractants to fruit flies in other countries, had been made by Mr. H. T. Pagden, Entomologist, of the Department of Agriculture, S.S. & F.M.S.

The substances tested were: clove oil, "essence of lemon," eugenol, iso-eugenol, geraniol and eugenol, butyl alcohol, geranium oil, propionic acid, fennel oil, butyric acid, ethyl laurate, bergamot oil, valerianic acid, citronella oil, lemon grass oil, kerosene, lauric acid, terpineol, bay oil, terpinyl acetate. Of all these, the only substances, of which quantities varying from 0.1 cc. to 0.5 cc. were used, which attracted flies in appreciable numbers were bay oil and iso-eugenol, the former attracting 608 *C. ferrugineus* and 30 *C. umbrosus*, the latter 751 *C. ferrugineus* and 37 *C. umbrosus* over a period of three days. The numbers of each sex were not counted in these tests.

Another substance—methyl eugenol—was tested subsequently and proved to be an effective attractant for *C. ferrugineus* since, in two traps, 805 and 2180 were captured, respectively, but these totals include only 5 females.

In most of the tests of the substances referred to, small drops were placed on pieces of card which were then suspended on fruit trees. The three substances, iso-eugenol, bay oil and eugenol, in addition to being tested in that manner were also tested by mixing them with whale oil and water or with water alone, the

resultant mixture being put into glass jars measuring 5 ins. wide by 4 ins. deep. These jars, over which a sheet of tin was fixed to protect the contents from rain, were suspended on the fruit trees.

In view of the fact that most of these substances are expensive and not easily procurable, a repetition of the tests was not carried out, but, instead, a search was made for other materials which might prove attractive. Trials were also carried out of baits the composition of which did not include expensive substances and which had been tried out in other countries.

At the Central Experiment Station, Serdang, where the tests were carried out, the principal fruit attacked by *C. ferrugineus* is the carambola, which has an undoubtedly pleasant odour and is outstandingly attractive to the flies.

It was this fact that led to an experiment with the juice of the fruits, expressed and placed in the glass jars of the same type as those in experiments described herein.

Two traps were prepared and were suspended in two carambola trees, and in a period of 35 days, 182 flies, of which 68 were males and 114 females, were captured. Fresh juice was put in the jars 17 days after the start of the experiment.

In investigations which have included the search for attractants which might entice both sexes of the flies, the procedure has generally been to use substances the odour of which is comparable with that of fruits or of essential oils from fruits. Attempts have also been made to ascertain whether the male and female flies have a distinctive odour which might also be given off by some organic or inorganic substance, but the results have been unsuccessful.

Other kinds of baits used during the present investigations are: Jarvis bait; lead arsenate or sodium arsenite, sugar and water; vinegar and sodium arsenite; wood wool impregnated with a solution of lead arsenate, sodium borate and sugar; fermented rice bran; "Argentine" ant poison;* and formaldehyde, sugar and water. Jarvis bait, which is composed of $\frac{1}{8}$ oz. vanilla essence, $\frac{1}{2}$ oz. Scrubbs ammonia and 26 oz. water, and the formaldehyde solution, of which the proportions are $\frac{1}{8}$ oz. formaldehyde (40%), 13 oz. sugar and 26 oz. water, have proved to be good attractants for both sexes of *C. ferrugineus;* the "Argentine" ant poison and the fermented rice bran bait, however, may be considered of negligible value.

Of the baits referred to in the preceding paragraph, the Jarvis and formaldehyde baits are the most effective, and, since they are composed of easily obtainable and cheap materials they are recommended for use by fruit growers for the reduction of the fly population.

As a matter of interest, it is worth recording that most of the female flies taken from the formaldehyde traps were found, on being dissected, to contain well-developed eggs.

* A description of this poison and its use will be found in the *Malayan Agricultural Journal* p. 40, Vol. XIX, 1931.

Experiments with the vinegar-sodium arsenate solution and the impregnated wood wool bait are still in progress, but, from the preliminary figures of the catches, these materials do not appear to show much promise as attractants.

Both of these baits are used in citrus orchards in Brazil, the impregnated wood wool being protected by a metal cover. In the present experiments in which this substance is being used, it is protected from rain by being placed in a kerosene tin from which the bottom and top have been removed, the tin being placed with its longer axis horizontal. In order to enhance the efficacy of this kind of trap the interior of the tins was smeared with an adhesive substance.

Incidentally, it has been found that the formaldehyde solution is an effective attractant for the ant *Tetraponera rufonigra*, which is frequently abundant on trees and is capable of inflicting a painful sting.

As mentioned previously in this section, the control of flies by means of baits must be considered complementary to other control measures, the chief being the removal of all damaged and fallen fruits unsuitable for human consumption, to a spot remote from the fruit trees, where they should be buried in pits.

As regards burial in this manner, it is necessary to emphasize that a layer of soil at least 6 ins. in depth should be placed on each lot of fruit thrown into the pit and that this soil should be thoroughly tamped down in order to consolidate it. Tamping is necessary, since emerging flies would be able to force a passage to the surface of loose soil and thus escape.

Destruction of infested fruits by boiling them in water is an effective means of reducing the fly population and is recommended for the control of fruit flies in small orchards. Burial or the boiling of fruits are also means of destroying the larvae of the citrus fruit borer *Citripestis sagittiferella*.

Much can be done to ensure a supply of sound fruits, particularly tomatoes, cucumbers, jack fruits, and carambola, if the fruits are protected by covering them with paper, cloth or netting covers at the stage of development at which they are most susceptible to attack, this stage varying according to the kind of fruit concerned, but it is generally a safe rule to apply such protective covers shortly after the formation of the fruit. According to Dr. T. W. Brown, Botanist, Central Experiment Station, Serdang, the Chinese adopt the method of protecting carambola fruit from fruit flies by use of a paper wrapper. They state that it is the only way to ensure a supply of sound fruits. The size of the material or bags used for protective covers will of course depend on the size of the mature fruit, unless fresh covers can be conveniently supplied before the fruit has reached maturity. If it is not proposed to renew the protective covers, they should be made so that the gradual expansion of the fruit will not be impeded.

For tomatoes it is best to use muslin bags, but for cucumbers, squares of ordinary newspaper rolled so as to form a tube, one end of which can be squeezed round the stem of the young fruit and fixed by means of cotton thread, can be used. Coarser material, such as gunny bags or calico can be used for the protection of jack fruits.

Finally, it is emphasized that clean culture, by which is meant the removal and destruction of injured and infested fruits, is the most important factor in reducing the incidence of attack by fruit flies.

Natural Enemies.

Three of the species of fruit flies referred to in this paper are known to be attacked in the larval stage by six hymenopterous parasites which, however, are not important factors in the control of these flies because their ovipositors are not sufficiently long to reach larvae which have penetrated deeply into fruits. Parasites have also been recorded from puparia but these too are of minor importance as a check.

Summary and Conclusions.

1. The present paper deals with the available information in respect of four species of fruit flies (Diptera—Trypetidae) namely *Chaetodacus ferrugineus* F., *C. cucurbitae* Coq., *C. caudatus* F., and *C. umbrosus* F., and data on the life cycle of *C. ferrugineus* are given.
2. Experiments in the control of *C. ferrugineus* by means of bait traps, protective coverings to fruits, and other methods complementary to these control measures are described.
3. Two bait traps have been adopted and have been found effective in the reduction of the fly population.
4. The conclusions, which must be considered of a somewhat preliminary nature, are that one type of control measure by itself will not necessarily be effective and that, whatever form of control is adopted, the practice of clean cultivation comprising mainly the complete destruction of damaged fruits by the methods described is absolutely essential.

Acknowledgments.

The writer is greatly indebted to Inche Mohammed Yusope bin Haji Mohammed Shariff, Inche Kamarudin bin Bahar and Inche Saleh bin Inoh for assistance in breeding and field work.

Reference.

1. 1935, Simmonds H. W. Fruit Fly Investigation, Bulletin No. 19, Department of Agriculture, Fiji.

Received for publication 16th February, 1940

OIL FROM *STERCULIA* SPECIES.

A Correction.

An account was given in a previous number of this Journal(1) of an examination of the two oils, pericarp oil and kernel oil, from a sample of fruits from Kumbang Pasang Estate, Brunei. No leaves or flowers accompanied the fruits, which were identified as *Sterculia* sp. The characteristics of the two oils were compared with those published as appertaining to *Sterculia foetida*.

Some years later a further consignment of these fruits was sent to Dr. T. P. Hilditch, Professor of Industrial Chemistry, University of Liverpool, for a more detailed examination. Professor Hilditch has for some years been engaged in a comprehensive investigation on natural fats, correlating the fatty acids present in the glycerides with the Natural Orders to which the plants belong.

Following our identification the results were published as appertaining to *Sterculia* sp. Later, Professor Waterman in Holland, who was engaged in an investigation on the kernel oil of *Sterculia foetida* obtained results very different from those published by Professor Hilditch.

Fortunately, through the kind co-operation of the manager of the estate, the Agricultural Officer, Brunei, was able to obtain complete botanical specimens from the trees from which the previous consignments of fruits had been obtained. The specimens were examined by Mr. M. R. Henderson, Botanist, Botanic Gardens, Singapore, who identified the species as *Dacryodes rostrata* (Bl.) H. J. Lam, belonging to the family Burseraceae. This species which was formerly included in the genus *Canarium* is also referred to in literature as *Canarium kadondon* Bennett.(2 & 3)

As mentioned in the original article in this Journal neither of the oils is of economic importance.

References.

1. Georgi, C. D. V. Oil from *Sterculia* species. *Malayan Agricultural Journal*, Vol. X, Nos. 10, 11 & 12, October, November and December 1922, page 259.
2. Ridley, H. N. The Flora of the Malay Peninsula. Vol. I. page 373.
3. Burkill, I. H. A Dictionary of the Economic Products of the Malay Peninsula, Vol. I, page 430.

Selected Article.

THE STORAGE OF FOODSTUFFS IN THE COLONIAL EMPIRE *

Introductory.

In Chapter IX of the First Report of the Committee of the Economic Advisory Council on Nutrition in the Colonial Empire, consideration was given to the question of the storage and preservation of foodstuffs. In paragraphs 195 and 196 of that Report mention was made that under colonial conditions the main problems of storage are not associated with the preservation of high grade commodities for the overseas markets, but rather with the maintenance, for local consumption, of stocks from one harvest to the next, from the crops grown by the individual or community, and the preservation of perishable products in order that they may be kept for a time, and if necessary distributed over a wider area.

The suggestion was made that steps should be taken to collect information, with a view to its subsequent circulation, regarding existing storage practices in the Colonial Empire. Much knowledge based upon experience is possessed by colonial peoples in regard to the storage of small quantities of food supplies, but nevertheless there are considerable losses in many areas as the result of faulty storing, and if practice in this respect could be improved, the general food supply position would be more favourable than it is at present. Particularly is this the case where seasonal shortfalls of food are likely to occur as the result of unfavourable weather conditions and consequent crop failures, and the question of satisfactory storage assumes added importance under war conditions when imports of food from outside sources are liable to serious reduction.(1)

In the following pages an attempt has been made to summarize available information on the subject in the hope that this may assist in focussing attention on a problem which has a considerable degree of importance under the present circumstances.

General Principles of Storage.

The successful storage of foodstuffs necessitates the satisfaction of two requirements (a) that the product to be stored, at the time of its introduction in the store, is in a condition suitable for storage, and (b) that the conditions of storage are such as to ensure that this state of affairs may be maintained satisfactorily during the period of the storage.

If stored products become invaded by insects or other destructive agencies, treatments may be available to reduce the damage, but it is far preferable to prevent loss by attention to the provision of suitable stores and to the conditions of storage.

---

* An article prepared by the Agricultural Advisers to the Secretary of State for the Colonies, with assistance from the Imperial Institute, Sir Guy Marshall, Director of the Imperial Institute of Entomology, and Professor J. W. Munro, Director of the Biological Field Station (Stored Products Research), Slough.

When considering storage, foodstuffs may conveniently be classified as follows:—

(1) the grain crops, with which may be included the pulses, and

(2) the root crops, including sweet potatoes, yams, cassava, etc.

In addition there are products prepared from grain such as rice, flour, brans and meals, as well as dried chips and meals prepared from root crops.

Stored grains and meals are liable to insect attack and may also be damaged by the growth of moulds and fungi if the conditions of storage are unsatisfactory, whilst they may also be attacked by rats and mice if they are not adequately protected against them.

Stored grain containing more than 15 per cent. of moisture is liable to "heat" as the result of the commencement of germination and the onset of attack by moulds and bacteria. Such grain is also particularly liable to attack by weevils since the optimum conditions for the existence of these insects in grain occur when the moisture content lies between 17 and 20 per cent. On the other hand, weevils are unable to live in grain containing less than 8 per cent. of moisture, and cannot carry on active life in the absence of an adequate supply of air.

Consequently it is important to ensure that before storage the moisture content of grain be reduced to a value which will remove the liability to "heating," inhibit the growth of moulds and afford some protection against insect attack, while during storage, conditions should provide that the moisture content of the stored grain does not increase by reason of inadequate protection. If these requirements are not satisfied loss is bound to occur; thus experiments carried out in the Federated Malay States in 1928/30 showed that when rice is stored in bags under the conditions which normally prevail in the commercial godowns it is barely edible after eight months. On the other hand when it is stored in bags under clean, rat-proofed and well-ventilated conditions it can be kept satisfactorily and without appreciable deterioration for a period of two years.(2)

As regards the moisture content of stored grains and meals, the factor of safety varies to some extent with different types of product, but it may be said broadly that for satisfactory storage the moisture content should not exceed 12 to 14 per cent. and may with advantage be lower. Maize exported from Kenya is not permitted to have a moisture content in excess of 12.5 per cent., and if maize on receipt at Mombasa has a higher percentage it has to be re-conditioned in the Maize Conditioning plant. This drying plant was obtained through the Crown Agents from Messrs. T. Robinson of Rochdale, England.

The reduction of the moisture content of grain to safe levels depends to a considerable extent on climatic conditions. Where the humidity of the air is low, grain crops can be dried in the field to satisfactory moisture content. Such conditions exist in many parts of Africa. On the other hand, where the atmospheric humidity is high, drying in the field is not practicable and special measures are required to reduce the moisture content to satisfactory levels; these may take the form of drying

on floors or barbecues, or even on the ground by the direct heat of the sun, the grain being spread out for the purpose and turned at intervals, provision being made to protect the grain from sudden showers of rain.

Various forms of grain-drier also exist in which a current of heated air is forced by blowers or suction fans through the grain; the employment of such devices may add materially to the cost if the moisture to be driven off is considerable. Their use is mainly limited to places where large quantities of grain are handled and stored in bulk and it is doubtful whether they are capable of being economically used for the handling of relatively small quantities of grain. Driers of this type were erected and operated during the last war in two West Indian Colonies and in Mauritius, and the experience there gained indicated that under those conditions the artificial drying of grain was a doubtfully economic procedure when the initial moisture is high. The maize conditioning plant operated in Kenya at Mombasa functions satisfactorily at relatively low cost as the reduction of the moisture content of the grain before it is ready for export is generally small.

Not only must the moisture content of stored grain be reduced to a satisfactory level but it must be kept at that level during storage, and in countries where there is marked variation of climate between the wet and dry seasons this may prove a factor of importance. Many grains are hygroscopic and their keeping power is liable to be influenced by the atmospheric humidity at the place of storage. Difficulties in this direction are illustrated by the fact that the length of time for which rice can be stored without deterioration in Burma depends to an appreciable degree on the climatic conditions at the time it is milled, rice milled during the dry season possessing better keeping qualities than rice milled during the wet season.

Containers for the storage of grain should be dry; they should be protected from invasion of moisture from the ground and also from the entrance of moist air during wet periods, while they should also be insect-proof and rat-proof.

Grain: Bulk Storage.

Various methods are used by the peasantry in tropical and sub-tropical countries for the storage of grain, some of which are reasonably efficient.

Provision is made, for example, by the populations in many parts of the Colonial Empire for the careful storage of their grain crops, and each homestead has its stores made of reeds or other material carefully mudded—sometimes only on the inside but more generally on both the inside and outside walls.([10]) These stores vary in size and shape, some of them being bottle shaped and spherical as in Meru, or beehive shaped as in Machakos in Kenya. In certain cases the stores are raised on posts from the ground as is common in the villages of Ceylon. In the majority of cases in Africa, the men and women own their crops individually, customs varying with different tribes, and in many areas so individual is the ownership of crops that adult members of a family keep their crops separately in different stores. In such cases the women are expected to feed the husband and the family from the store of food in their possession, whilst the husband, though he may in cases of need supplement her stocks, uses his supplies for the preparation of beer

and for the entertainment of guests. In the northern territories of the Gold Coast, there is also a store of food in the keeping of the woman which is reserved for the scarcity period and this is the last of the stores in any season to be opened. Yam producers in West Africa equally store their crops individually on wooden racks, which are shaded, but exposed to the air, with the woman providing for the needs of the family and the man using his crops either for sale or for the entertainment of guests.

The grain stores are usually cleaned, and in many cases remudded or given a coating of cow dung, before the crop of the season is placed in them, and a considerable degree of knowledge is possessed by the people regarding the keeping qualities of the different types of grain raised. It is generally accepted, for instance, in West Africa that certain yellow-grained guinea corns keep for only short periods of time, whilst harder white-grained types can be stored without damage for lengthy periods. It is held with justification in many parts of Africa that the grain of bulrush millet (*Pennisetum typhoides*) is less liable to damage than is the grain of guinea corn, and again that the grain of *Eleusine corocana* keeps well if dry when stored, and is not so seriously damaged by insects as other grains.

In the drier areas of Uganda, a striking feature of the countryside is the communal storage of grain, in which are stored considerable stocks of grain from one season to another against scarcity or famine. These communal granaries, consisting of a large number of round mudded store houses with grass covered roofs, are well controlled and maintained, although so far it has not been possible to introduce a satisfactory system of protection against rat damage and the accompanying danger of providing foci for the spread of plague, which is a rat-borne disease.

In Sierra Leone also it is held that rice in which ripe pods of chilli are introduced is less liable to insect damage than where this addition is not made, but whether this claim is justified has yet to be investigated.

Very fairly efficient types of granary for the bulk storage of paddy are in use among Malay rice growers in the Malay States.(5) In the State of Kedah two types of granary occur. In their original forms, they are made of plaited bamboo, but more recently galvanised iron has also been employed. They comprise a larger square type, some of which are capable of holding several thousand bushels of paddy, and a smaller round type which holds a few hundred bushels. They are erected under cover and raised off the ground on wooden supports which are protected by rat guards. In them paddy can be stored without depreciation for many months; if the grain is attacked the damage is usually confined to the superficial layers. In some cases the wooden supports on which the stores have been erected are not sufficiently high and the rat guards are occasionally inadequate. Rats are known to be able to make a vertical leap of 2 feet 6 inches and to crawl around flanges which are less than 9 inches in total width. Stores to be protected adequately against rats should have their floors not less than 2 feet 9 inches from the ground and be protected at this height by flanges or pieces of kerosene or petrol tins which extend from the sides of the store or its supports for a distance of not less than $4\frac{1}{2}$ inches.

In Nyasaland an attempt was made in 1931/32 with some success to develop the use of communal grain stores of a type originally suggested by the Tanganyika Department of Agriculture. They consisted of a cylindrical mudded container standing on a mudded platform about four feet from the ground. In the final form the top was also mudded and a small manhole cut in the side for filling. It was found that in stores of this type, provided they were fumigated at the commencement of storage, grain could be kept for several months without deterioration.(3)

In many parts of Africa and elsewhere maize, after drying in the field, is stored on the cob in the unhusked condition either in cribs or on beams, shelves or racks in houses. Cobs with tightly fitting sheaths are rarely infested. This method is satisfactory for keeping small quantities of maize for relatively short periods, but is not generally suitable for storing large quantities for any considerable length of time.(2)

Various types of smaller containers have also been evolved by peasant cultivators for the storage of grain. These may take the form of earthen jars or metal containers, and petrol tins have been successfully used. In the Gold Coast maize stored in airtight petrol tins showed no loss of weight and was free from weevils after eight months, while maize stored in the husk showed a loss of 25 per cent. in weight and was of less attractive appearance.(2)

In India, grain stored in metal or earthenware containers has been successfully sealed and kept airtight by covering it with a layer of sand, a sheet of cloth or a piece of iron or wood being placed beneath the sand layer to prevent the grain becoming mixed with the sand.(2)

Grain is often stored underground in India and elsewhere in more or less airtight pits. Experiments in Australia have shown this to be an effective method of controlling a number of insects which infest it, the pests being killed by the carbon dioxide given off by themselves and by the grain. This method of storage may be of value where large stocks of grain have to be stored for long periods. In using it the grain should fill the available space so that the store contains as little air as possible.(2)

For the large scale bulk storage of grain the most satisfactory method is in large metal or concrete tanks, which can be hermetically sealed and which are provided with facilities for fumigation. Where, as in parts of South Africa, maize can be dried in the field down to moisture contents of 8 to 10 per cent. it can be stored in tanks with open tops without deterioration, as at these moisture values it is largely immune from insect attack. Where storage at higher moisture content has to be undertaken closed containers are necessary.

Galvanised iron containers are probably the most efficient and economical for the storage of maize. They can be constructed in sections, the sides being riveted and soldered at the joints; the lower end of each section should overlap the section below to keep out air and moisture. The tank itself should rest on a wooden or concrete platform; it is filled by means of a hole in the roof which can be hermetically closed by means of a flanged lid. Tanks of this sort are widely used in the United States of America for the farm storage of grain.

Grain and Meals: Storage in Bags in Stores.

While the bulk storage of grain is the most satisfactory method, storage in bags often has to be undertaken, and in any case bulk storage is not in general applicable to meals, flours or rice. Under these conditions special attention should be paid to the construction of the store and to the conditions of storage. Stores are best constructed of brick or concrete, and they should at least have a concrete floor; all corners should be rounded to prevent accumulation of debris in which insects may breed, while the sides, floor and roofs should be free from cracks and openings in which insects might harbour. They should be well ventilated and should if possible have a through draught. All windows should be screened with fine mesh wire gauze, while double self-closing doors should be provided in large stores. Satisfactory rat-proof granaries have been erected at Colombo in Ceylon and at Port Louis, Mauritius, for the storage of rice in bags.(4)

All stores should be rat proofed, since otherwise a large amount of damage may occur, while there is also the danger of providing foci for the dissemination of rat borne diseases, particularly plague. When grain or meals are stored in bags it is important to prevent them coming into contact with the floor. This can be achieved by stacking in rows on rafters or beams running parallel with the length of the building and allowing space for circulation of air and for inspection. In Southern Rhodesia newly bagged grain is often pigeon-hole stacked in order to hasten drying.

Maize meal does not keep after it is ground if the germ is not removed, owing to the oil contained in the germ which rapidly turns rancid and imparts an objectionable taste to the product. Maize meal intended for storage for any lengthy period accordingly requires to be degerminated. Machines for doing so are on the market. From a nutritional point of view, however, it is undesirable to eliminate the germ, which is rich in proteins and fats and has high nutritive value. One way of meeting the difficulty is to store maize in the form of grain and to grind small quantities as required to meet immediate demands.

Pests and Pest Control.

Insects Attacking Stored Grains, Flour and Meals.

Grains and their products, meals and similar materials prepared from root crops are liable to attack by a number of insects. These include the grain weevils characterized by their long snouts, examples of which are the Grain Weevil proper (*Calandra granaria*) and the Rice Weevil (*Calandra oryzae*). The females may live for 4-5 months and lay from 100 to 200 eggs, from each of which a small grub hatches out and at once starts to feed. The grub or larval stage is passed inside the grain and by the time the grub is fully grown the whole of the grain has been hollowed out, and in this shell pupation takes place. The time of development depends on the temperature; the lower the temperature the longer the life of the weevil, while the life period is also affected by moisture conditions and by the kind of food.

(b) The Saw Toothed Grain Beetle (*Silvanus surinamensis*) which derives its common name from the presence of tooth-like projections on the lateral margins of the thorax. Both larvae and adults feed on flour meals, nuts and seeds of several kinds.

(c) The Flour Beetles (*Tribolium* spp.) which are commonly associated with weevils in grain damaged by the latter although they occur more commonly in flour and meals. They differ from the weevils in having no snout, and are lighter in colour and flatter bodied than the weevils, while the grub does not remain inside the grain but wanders freely through and over its food. The time of development from the egg to the adult is about forty days.

(d) Pea and bean weevils belonging to the genus *Bruchus*—short in body with thick snouts and prominent antennae. The larvae are short, thick grubs, which live and complete their development within the seeds of peas and beans. The female deposits eggs on or in the seed pod and the young larvae penetrate into the developing seed.

A number of moths also attack grain and flour, among which under tropical conditions various species of *Ephestia*, (known as the Mediterranean Flour Moth) the Cacao Moth and the Fig Moth may be cited. These are less important than the weevils but where heavy infestation has been allowed to develop considerable damage may be done.

In addition there are a number of mites which attack stored grains and foodstuffs and which, although less obvious than the beetles and the moths, occur in enormous numbers and do much damage at times.

The Manner in which Stored Products become Infested with Insect Pests.

Infestation of stored products by insects may occur either (a) before storage, i.e. in the field or in course of transit from the field to the store, or (b) during storage, as the result of placing them in stores which have themselves previously become infested. Infestation in the field occurs in the case of the Bean and Pea weevils, and it has also been shown that infestation of cacao beans by Pyralid moths originally commences on the plantation; the moths come in the night and deposit their eggs on the beans exposed on the drying platforms.(6) This type of infestation cannot be entirely prevented but by proper precautions it may be reduced to a minimum. In Southern Rhodesia it has been established that maize in the fields is infested with weevils from various sources such as farm stores, maize stocked at rail-heads, shelling dumps, etc. The stores become infested by weevilly maize brought in from the fields after harvesting time.

With the liability of produce to infestation in the field it is easy to see how warehouses and granaries may become infested and lead to the infestation of produce stored therein if precautionary measures are neglected. The importance of cleanliness in barns and adjacent buildings from which insects might reach the stores accordingly cannot be too strongly emphasized.

Precautions against Infestation.

The screening of windows and doors can do much to prevent pests from spreading, while good lighting, thorough ventilation and relatively low temperatures are also important as grain moths and weevils thrive best in dark places and a still, warm atmosphere. Store rooms should be completely emptied and thoroughly cleaned at least once a year and all emptied barrels, sacks and other containers should be sterilized before they are used again. This sterilization may be done by means of dry heat or sun or by use of boiling water. Storerooms can be disinfected by spraying or washing the floor, ceiling and walls with kerosene emulsion, diluted carbolineum or similar disinfectant preparations. Whitewashing the walls and ceilings should also be regularly effected as it assists the detection of uncleanliness and the presence of destructive insects. All rubbish and refuse from the stored product should be regularly swept up and destroyed by fire, particularly from under the duck boards on which bags are stacked: the regular movement of stored material acts as a check on the multiplication of moths and weevils. Fresh material should never be stored with infested material or in storehouses or containers that are not scrupulously clean; if stores become infected to such an extent that it is in practice impossible to free them from infestation they are better destroyed.

When grain has to be stored in large quantities for a considerable period it is wise to screen it when it is received, since this has the effect of eliminating weevils before they can lay their eggs, and the danger of future infestation is minimised. The longer screening is delayed the greater will be the subsequent infestation.

The problem presented by the infestation of commodities in store is twofold, namely infestation brought in by goods introduced into the store which may be called the "incoming population," and infestation of the store itself which may be called the "resident population." Generally, the destruction of the incoming population can be more easily attained than that of the resident population. Incoming goods can be treated if necessary in special containers, but the stores with their more complex structure and almost infinite capacity for harbouring insects are more difficult to clean up. It often happens that for the treatment of incoming goods fumigation is wholly satisfactory, but for cleaning storage sheds or warehouses fumigation may be impracticable or may have to be supplemented by the use of sprays. In this connection the following elementary precautions to prevent the spread of infestation deserve consideration:—

(1) Infested goods should be segregated. Containers, whether sacks or baskets or drums, which have carried infested goods should not be used again until disinfected or sterilized.

(2) Broken goods, screenings and sweepings are especially prone to infestation. They should be isolated and sterilized or burned at the earliest opportunity. On no account should sweepings be returned to the main store.

(3) New season's goods should never be stored with old season's goods unless these older goods are known to be clean.

(4) In inspecting goods for the presence of insects the following places should receive special attention:—

(a) between adjacent sacks and baskets;
(b) between these and the walls of the store;
(c) in the ears and folds at the top of sacks and in the wicker work at the tops and bottoms of baskets;
(d) at the highest or the darkest places in bulked goods;
(e) on the floor and especially on the walls of stores near infested goods;
(f) on the floors of carts, wagons or sledges used in harvesting.

Insects and mites increase in numbers only when they have an undisturbed food supply and breeding ground. Obviously, therefore, neglected heaps of old grain or meals, sweepings, old sacks, and long-accumulated debris in corners and in cracks between floorboards form ideal breeding grounds for them and the first step in the war against these pests is to see that no such breeding grounds are allowed to remain.

(To be concluded)

Notes and Comments.

IMPERIAL POLICY ON COLONIAL DEVELOPMENT AND WELFARE.

In a White Paper issued by the Imperial Government in February publicity is given to a new scheme designed to give financial aid to the Colonies, Protectorates and Mandated Territories to assist colonial development in its widest sense, not only for schemes involving capital expenditure, but also for helping to meet recurrent expenditure in the Colonies on certain services such as agriculture, education, health and housing.

To implement this scheme the Imperial Government propose to introduce legislation providing in a new vote in the Estimates (which will replace the Colonial Development Fund) assistance to Colonial Governments up to a maximum of £5,000,000 a year for ten years.

In planning expenditure from the new source the Imperial Government will enlist the help of a Colonial Development and Welfare Advisory Committee, which will be composed partly of official and partly of unofficial members.

Separate provision is also to be made for Colonial research, (hitherto assisted out of the Colonial Development Fund) up to a maximum of £500,000 a year, to be administered with the assistance of the new Colonial Research Advisory Committee.

The intention is that £5,000,000 and £500,000 a year respectively should be maximum figures, which will not be attained at once. It is realized that it will take time to frame careful plans of development and research and to translate them into operation. These figures will be subject to review from time to time and should experience show that they are insufficient it will always be open to Parliament to increase them.

The fact that a Colony receives assistance under these schemes will not entail upon it the system of financial control which is now associated with the receipt of grants-in-aid. From London there will be assistance and guidance, but not a spirit of dictation. The new policy of development will involve no derogation from the rights and privileges of local legislatures upon which rests a large measure of responsibility for improvement in conditions. Neither is it suggested that there should be any uniform system of co-ordination throughout the Colonial Empire. Differing conditions will require some variation in method of dealing with this problem. "The whole effect will be one of collaboration between the authorities in the Colonies and those at Home; there must be ready recognition that conditions vary greatly from Colony to Colony, and that Colonial Governments—who best know the needs of their own territories—should enjoy a wide latitude in the initiation and execution of the policy, the primary purpose of which is to promote the prosperity and happiness of the people of the Colonial Empire."

The New Laboratories of the Department of Agriculture, Kuala Lumpur.

A Portion of the Entomological Laboratory, Department of Agriculture, Kuala Lumpur.

The policy outlined above will replace that financed from the Colonial Development Fund which was limited to £1,000,000 a year. The object of the original Fund was to promote commerce with, or industry in, the United Kingdom by assisting the development of agriculture and industries in the Colonies. The present scheme therefore aims at the further active development in natural resources, so as to provide an improved standard of life in the Colonies.

SALE OF TEA IN THE UNITED KINGDOM.

The import of tea into the United Kingdom is prohibited except tea under contract with the Ministry of Food. The Ministry is prepared to enter into three years' contracts with Malayan producers on an f.o.b. basis.

The form of contract and prices of various grades are under negotiation between an accredited representative of Malayan producers and the Ministry.

NEW LABORATORIES FOR THE DEPARTMENT OF AGRICULTURE.

Reference was made in a previous number of this Journal* to the construction in Kuala Lumpur of modern laboratories to house the whole of the Research Branch of the Department of Agriculture and the re-allotment of the rooms vacated thereby in the existing building.

The laboratories were completed during 1939 and all transfers have now been effected.

The new buildings comprise two double-storied blocks situated on the side of the hill to the north of the original building and aligned to give a continuous frontage.

The siting on the hill necessitated heavy cutting and filling. The solid nature of the subsoil rendered normal foundations possible with the exception of one corner in one block where extra excavation was necessary.

The buildings are of latest design, the use of structural timber being kept to a minimum. Roof trusses, windows and doors are of steel, and all floors, stairs and pillars are of concrete with Granolithic Terazzo surfacing. Brick work was laid in cement mortar and the whole structure has been designed to give a maximum resistance to ravages from termites and dry rot. It is anticipated that the maintenance work in connexion with these buildings will be confined to painting and minor repairs only.

'Calorex' glass was used throughout the buildings for heat insulation, and all ceilings are of asbestos.

The dimensions of each building are as follows:—

	feet.
Length	146
Breadth	46
Height to eaves	32

* *Malayan Agricultural Journal*, Vol. XXV, No. 10, October 1937, page 435.

A constant high pressure water supply has been provided by the construction of a storage tank behind the buildings on top of the hill approximately 200 ft. high.

A combined boiler-house and coal shed has also been erected behind the far block.

The buildings were designed in the Office of the State Engineer, Selangor, and the approximate cost of both blocks, including approach roads, garage, lavatory, water supply and boiler-house amounted to $140,000.

With regard to the allotment of the buildings, the Divisions of Chemistry and of Soils and Plant Physiology are accommodated in the farther building from the original building, Chemistry on the ground floor, Soils and Plant Physiology on the upper floor.

In the other building laboratories and offices for the Divisions of Plant Pathology and Botany are provided on the ground floor with the Division of Entomology on the upper floor.

The illustrations show a general view of the siting and alignment of the two blocks and the interior of the Entomological Laboratory.

ANNUAL REPORTS OF THE FIELD BRANCH FOR 1938.

For some years past, the Department of Agriculture, S.S. and F.M.S., has published annually as a Special Bulletin the reports of the Field Branch, and subscribers to the series of Special Bulletins have therefore received copies of these publications.

Owing to the necessity of curtailing the amount of paper used, a very limited number of copies of the 1938 reports has been printed, and as this number was insufficient to permit of general distribution, the publication is not included in the list of Special Bulletins of the Department.

There are, however, a limited number of copies still available which are on sale at 50 cents (Straits Settlements currency) per copy, post free. Application for copies should be addressed to the Agricultural Economist, Department of Agriculture, Kuala Lumpur, F.M.S.

SERANGOON GRASS.

Correction.

In Agricultural Leaflet No. 15 (Second and Revised Edition) entitled "Lawn Grasses," Serangoon grass is referred to as a strain of *Cynodon dactylon*. *C. dactylon* is the botanical name for Bermuda grass.

As a result of the examination of various botanical specimens of the grass in collaboration with the Director of Gardens, S.S., Singapore, it has now been established that Serangoon grass is allied to Blue Couch grass and not to Bermuda grass. Blue Couch grass is known botanically as *Digitaria didactyla*.

Specimens of Serangoon grass will be forwarded to the Royal Botanic Gardens, Kew, England, for identification in due course. At present an uncertainty exists as to whether the correct name is *D. didactyla* or *D. marginata*; our identification tends to favour the former species.

THE M.A.H.A. MAGAZINE.

The January 1940 number of *The M.A.H.A. Magazine*—the official organ of the Malayan Agri-Horticultural Association—is devoted almost entirely to vegetable growing. "Vegetable Growing in Home Gardens," a talk prepared by the Department of Agriculture and broadcast from the B. M. B. C. Station, Singapore, in December, contains a great deal of information presented in a convenient form. Other articles on this subject are "Green Vegetables," "Long Beans," "Malayan Keladis and Other Edible Aroids," and "Vegetables and Human Nutrition."

In view of the present importance of growing foodstuffs, the publication of this special vegetable-growing number is most opportune.

Members of the Malayan Agri-Horticultural Association receive a copy of the quarterly Magazine free; annual subscription to non-members is $1.20 (post free in Malaya); single numbers 30 cents post free from the Honorary Editor, *The M.A.H.A. Magazine,* Department of Agriculture, Kuala Lumpur.

MARKET FOR DERRIS ROOT.

The Department of Agriculture has received several enquiries from abroad from firms wishing to be placed in touch with growers of derris root. In their own interests growers of this product are therefore invited to inform the Department of the area under this crop, the variety planted, date when it is expected to harvest the crop, and probable quantity of root they will wish to sell. This information should be given as early as possible so that contact between seller and buyer may be established by the time the crop is lifted.

Departmental.

FROM THE DISTRICTS.

Compiled in the Office of the Chief Field Officer from Monthly Reports of Agricultural Officers.

February, 1940.

The Weather.

In Kedah the weather has been extremely dry, except in the Kulim District in the extreme south where conditions were normal. Similar dry weather has also been experienced in Penang; at Ayer Itam during the past two months only just over ½ in. of rain has fallen.

In other parts of the country the weather has been hot and dry with little rain: these conditions are normally experienced during this season of the year. In Selangor the weather was wetter than during January, and the total precipitation for the month was rather above the average.

Crop Reports.

Rubber.—Only minor fluctuations in the price occurred. Large quantities of acetic acid have recently arrived in the country and supplies of listed coagulants at the moment are adequate. In Selangor the distribution of coagulants has now been placed in the hands of licensed dealers, and the change over from departmental sales to sales by licensed dealers is proceeding in all administrations. The Government retains adequate powers of inspection and supervision to ensure that the dealers conform with the regulations.

In Kelantan the use of alum and other undesirable types of coagulant has always been very common. The present method of distribution of acetic and formic acid whereby every small-holder receives a ration is likely to do much to convince them that it is possible to obtain better results by using these acids. At present also, alum is rather more expensive than acetic or formic acid. In all areas supplies of sulphuric acid and other non-listed coagulants are on sale and are used by small-holders to a varying extent, either as the only coagulant or to supplement the cultivator's allowance of acetic acid.

The use of fermented coconut milk as a coagulant appears to be becoming more popular in some areas where coconuts are available. In parts of Selangor it is becoming customary to collect the coconut milk at copra kilns where large numbers of nuts are split. The milk is fermented for 4 or 5 days in 30 gallon earthenware jars and is then sold at 20 cts. per demijohn. Some small-holders use this home-made coagulant to eke out their ration of acid: for this purpose they mix a small quantity of acetic or formic acid with the fermented coconut milk.

The preparation and use of coconut milk as a coagulant have been given wide publicity among small-holders. A circular in Malay, Chinese and Tamil published by the Rubber Research Institute has lately been issued. Asiatic Rubber Instructors

also give frequent demonstrations of the method advocated for its use. At a recent demonstration in Pahang, 3 cigarette tinfuls of coagulant to each pan of latex produced perfect coagulation within 2 to 4 hours time. After smoking, this sheet received the same price from the dealer as other sheet made in the ordinary way.

In Kedah owing to the extremely dry weather and the incidence of 'wintering' tapping on many holdings has been suspended. In other parts of the country also yields during this period have been low.

In the Ulu Langat District of Selangor, where on many holding the trees are old and poor yielding, it is reported that interest in replanting has not diminished as it has of late in other districts. Many areas that have recently been cleared for replanting have been dressed with artificial manures. One group of Chinese small-holders has purchased nearly 4 tons of artificials at $100 per ton for use on their holdings.

A demonstration of budgrafting of rubber was held on three days at the Ayer Tawar Agricultural Station, Perak; 156 small-holders—Malays and Chinese—attended.

Padi.—In north Kedah harvesting is almost completed. At the end of February considerable areas in the central and south districts remained to be harvested.

In north Krian harvest has been in full swing. Yields in many places are good and the crop in this area is likely to be at least 10 per cent. better than last year. In south Krian yields will be about the same as last season. Owing to the dry weather ripening has been even and the quality of the grain is good. On the whole harvesting is about a fortnight earlier than during the previous two seasons.

The numbers of Indian and Malay labourers who enter the district to assist with the harvest have been decreasing for several years, yet even without this outside help, the harvest will be completed even earlier than usual this year.

In Perak Central the crop also appears to be better than last season.

At Sungei Manik harvesting is taking a long time as there is a shortage of labour. Fewer labourers have come for the harvesting this year, and also many cultivators are busy clearing jungle in Stage IV. It is reported that in this area the use of the sickle in place of the "tuai" is becoming very much more general. During December and January many sets of sickles and threshing tubs were ordered direct from Krian.

The padi crop in Kuala Selangor and Panchang Bedena on account of drought has been a complete failure with the exception of some 900 acres at Mukim Sempadan where irrigation water is available and excellent crops are to be seen.

Following the partial failure of the padi crop in Malacca the Resident Councillor has appointed a committee to enquire into the reasons thereof and to suggest methods of relief in the affected areas.

The new Government Rice Mill at Teluk Anson is now working. Up to the end of February the mill had not been able to purchase any padi locally as Chinese dealers were buying up all that was offered at $2.75 to $3 per picul. By the end of the month the price had dropped to normal levels and local growers then began to enquire about conditions of sale to the mill.

Pineapples.—A compromise between the demands of strikers and the offers of pineapple-factory owners was arrived at and the factory hands returned to work early in the month. However, there was very little fruit available for canning so that factories were able to operate for only a few days in each week.

Poultry.

An experiment has been begun in Krian to ascertain the result of distributing Rhode Island Red chickens to small-holders through Chinese hatcheries. During the past $2\frac{1}{2}$ months 913 eggs from Selama and Kuala Kangsar Agricultural Stations have been sent to Krian hatcheries and out of these 287 chicks have been hatched and sold.

A trial of cross-bred poultry (R.I.R. x local) versus local birds, fed in much the same way as the local peasantry feed their birds, is being undertaken at several Agricultural Stations. Results to date show that in some of these experiments the cross-breds are superior in respect of growth as indicated by weight records.

FERTILIZER PRICES, MARCH, 1940.

The following are the prices current for the month of March, 1940, of some of the more important fertilizers.

Product.	Analysis				Price per ton $
	Nitrogen (N)	Phosphoric Acid (P_2O_5)		Potash (K_2O)	
		Soluble	Insoluble		
Sulphate of Ammonia ...	20.6	—	—	—	114.00
Calcium Cyanamide ...	20.6	—	—	—	120.00
Muriate of Potash ...	—	—	—	60	150.00
Sulphate of Potash ...	—	—	—	48	not available
Superphosphate (concentrated) ...	—	39	—	—	140.00
Superphosphate ...	—	16-18	—	—	65.00
Basic Slag ...	—	16*	—	—	66.00
Rock Phosphate (Christmas Island) ...	—	11*	38‡	—	37 ¶
Rock Phosphate (very finely ground Gafsa) ...	—	11*	26 - 28‡	—	40.00
Lime ...	—	—	—	—	20.00

* Citric soluble. ‡ Total ¶ $35.00 per ton *ex* warehouse, Singapore.

Quotations are *ex* warehouse, Port Swettenham, Klang, Singapore and Penang, with the exception of muriate of potash which is *ex* warehouse, Port Swettenham, Klang and Singapore.

Statistical.

MARKET PRICES.

February 1940.

Major Crops.

Rubber.—The market remained relatively steady during February. No. 1. X. Ribbed Smoked Sheet opened at 37 cents per lb., and after rising suddenly to 39⅛ cents on the 10th, remained between 38¼ and 38¾ cents until the end of the month, when it fell to 37½ cents, closing at 38⅛.

The average of daily quotations for the month was 38.04 cents per lb., as compared with 37.84 cents in January. The London average price was 12.60 pence per lb., and New York 18.67 cents gold, as compared with 11.81 pence and 18.95 cents gold respectively in January.

Prices paid for small-holders' rubber at three centres during the month are given in Table 1.

Table I.

Weekly Prices Paid by Local Dealers for Small-Holders' Rubber, February, 1940.

(Dollars per picul of 133 1/3 lbs.)

Grades	Kuala Kangsar, Perak	Kuala Pilah, Negri Sembilan			Batu Pahat, Johore.			
	28	1	15	29	7	14	21	28
Smoked sheet ...	45.00	45.00	45.50	45.00	43.90	45.00	—	—
Unsmoked sheet ...	43.00	43.50	—	43.00	42.38	42.95	42.78	42.50
Scrap ...	—	—	—	—	—	—	—	—

Transport by F.M.S.R. lorry service Kuala Pilah to Seremban 12 cents per picul, to Malacca excluding duty, 25 cents per picul, by rail Seremban to Penang $1.24 per picul, Seremban to Singapore $8 per ton.

Transport from Batu Pahat to Singapore by lorry, excluding duty, 90 cents per picul.

Transport from Kuala Kangsar to Prai by railway $6.20 per ton.

Transport from Kuala Kangsar to Singapore by railway $10 per ton (minimum consignment 5 tons).

At Kuala Pilah the standard deduction for moisture in unsmoked sheet is 5 per cent.

No purchases of rubber at Kuala Kangsar on the 7th, 14th, and 21st February, at Kuala Pilah on the 8th and 22nd February.

Palm Oil.—The following information is taken from *The Oil and Colour Trades Journal,* 19th January, 1940. Controlled maximum prices to large trade consumers and primary wholesalers to operate to 3rd February: palm oil, refined, deodorised £27 per ton, refined (hardened), deodorised £31. Under Acid Oils, palm oil is quoted at £14 per ton, and £18 (hardened).

Local sales of palm oil, 5 per cent. f.f.a., in sellers' drums, were made during February at the following prices: unbleached oil $185 and $190 per ton f.o.b. Port Swettenham, and $183 per ton f.o.b. Singapore.

Copra.—Sun-dried copra remained unchanged at $3.80 per picul, with the mixed grade 35 cents per picul lower.

It is understood that a controlled price of £12 per ton for f.m.s. Straits copra is in force in the United Kingdom.

Coconut oil was sold in Singapore during February at an average price of $10 per picul f.o.b.

Copra cake continued unchanged at $2 per picul.

Rice.—The Singapore average wholesale prices of rice per picul in December, 1939, were as follows:—Thailand No. 2 Ordinary $4.43, Rangoon No. 1 $4.52, Saigon No. 1 $3.92, as compared with $4.05, $4.35 and $3.50 in November, 1939, and with $4.27, $3.20 and $3.65 in December, 1938. The average prices for the year were $3.98, $3.62 and $3.47 respectively, as compared with $4.26, $3.74 and $3.94 for the year 1938.

The December average retail prices in cents per gantang (gallon) of No. 2 Thailand rice were:—Singapore 28, Penang 29, Malacca 30, as compared with 30, 30 and 30 respectively in November. The averages for the year were 27, 31 and 29 respectively as compared with 28, 32 and 28 for the year 1938.

The average declared trade value of imports during December was $3.99 per picul, as compared with $3.79 in November and $3.89 in October. The average for the year was $3.75 as compared with $3.93 for 1938.

Padi.—The Government Rice Mills, Perak, are now paying a guaranteed price of $2.50 per picul for padi, plus a bonus of 10 cents per picul for pure strain S.K. 48 padi. The Government Rice Mill, Temerloh, Pahang, was paying $2.25 per picul during February.

Retail prices of padi per 100 gantangs (gallons) were as follows:—Kedah $8, Province Wellesley and Penang $8.80, Krian, Perak, $8.50 to $9.50, Perak Central $9.50, Perak South $8 to $10, Selangor $11 to $12 (Kuang), $12 to $14 (Kuala Langat), $18 (Kuala Lumpur), Negri Sembilan $8 to $12, $15 to $16.50 (Seremban and coast), Pahang $7 to $12 (North), $9.50 to $13 (South and Temerloh), $10 to $14 (East), Malacca $12 to $14 (the high figure in Malacca is due to the poor harvest), Kelantan $10.25, Brunei $10 to $15, $10 to $16 (Belait), $10 to $12 (Tutong).

Pineapples.—There was again no change in prices of canned pineapples as fixed by the Central Board of Packers. They were as follows per case of 48 cans of 1½ lbs. each:—G.A.Q.: Sliced Flat $4.80, Sliced Tall $4.95, Cubes $4.85; Golden: $5.40, $5.55 and $5.45.

There was also no change in fresh fruit prices which are now under the control of the Central Board.

Beverages.

Tea.—No London prices are available.

The latest Colombo prices available, quoted from *The Ceylon Tea Market Report* of 27th February, 1940, of the Colombo Brokers' Association, are as follows, in rupee cents per lb.:—High Grown Rs. 1.00, Medium Grown 83, Low Grown 80.

Coffee.—Liberian coffee was quoted throughout the month in Singapore at $17 per picul. Excelsa rose from $13 to $15.50, to average $14.38, and Robusta rose from $9 to $9.50, averaging $9.38 per picul.

The average of highest and lowest quotations in Singapore for Palembang coffee was $8.80 to $11.55 per picul, and for Sourabaya $14.30 to $15.25. The January average prices were $11.12 to $13 and $12.19 to $13.69 respectively.

Spices.

Arecanuts.—The averages of the Singapore Chamber of Commerce quotations per picul, which were stated to be approximate, were:—Best $5.94, Medium $5.50, Mixed $5.19.

The averages of the highest and lowest quotations per picul in Singapore were as follows:—Splits $4 to $5.33, Red Whole $5.05 to $6.20, Sliced $7 to $9.80; as compared with $5.12 to $6.62, $5.31 to $7.41 and $8.62 to $11.75 in January.

Pepper.—Singapore Black was quoted throughout the month at $8.50 per picul, and Muntok White at $14.50. The market for Singapore White continued nominal with no quotations. January average prices were $8.62 and $15.75 respectively.

Nutmegs.—110's were quoted throughout the month at $34 per picul, as compared with the January average price of $35. 80's continued unchanged at $41.

Penang dried nutmegs were sold at $25 per picul 1st quality, $15 2nd quality.

Mace.—A nominal market with no quotations. Locally produced mace, dry, was sold in Penang at $80 per picul 1st quality, $65 2nd quality.

Cloves.—A nominal market with no quotations. Penang cloves, dried, sold in Penang at $82 per picul 1st quality, $65 2nd quality, $45 3rd quality.

Cardamoms.—Green cardamoms were quoted in *The Ceylon Chamber of Commerce Weekly Report* of 26th February, 1940, from Rs. 1.40 to Rs. 1.59 per lb.

Miscellaneous.

Derris.—Signs of inactivity on the part of buyers in the main consuming centres caused prices to weaken. Roots were freely available at the following average prices:—$11 to $12 per picul for roots sold on a basis of ether extract, $22 to $24 for root sold on rotenone content. The January average prices were $11 to $12 and $22.50 to $24.50 respectively.

Gambier.—The market for Block remained nominal with no quotations and Cube No. 1 continued unchanged at $15 per picul.

Sago.—Prices fell during February. Pearl was quoted throughout the month at $9.25 per picul, and Flour, Sarawak Fair, averaged $6.25. The January average prices were $10.69 and $7.31 respectively.

Tapioca.—Flake Fair was quoted throughout the month at $10 per picul, Seed Pearl and Medium Pearl at $11. The January average prices were $10 and $11.25 respectively.

Tobacco.—Prices of prepared tobacco per picul in Kelantan during February were: 1st quality $110 to $160, 2nd quality $75 to $128, 3rd quality $50 to $112. In Perak Central the corresponding prices for cut tobacco were $63, $55 and $30, and for dried leaf $43.50, $32.50 and $17.50. In Perak South, locally prepared tobacco was sold at 60 cents to $1 per kati, while the prices of the three grades of dried leaf were $40, $35 and $30 respectively; in Pahang the grades were $20 to $30, $10 to $26, and $5 to $20, and in Negri Sembilan $26 to $30, $16 to $25, and $15 to $20 ($8 to $10 Kuala Pilah). Prices elsewhere were: Kedah $52 to $54, Province Wellesley and Penang $32, Malacca $45.50.

The above prices are based on London and Singapore daily quotations for rubber, on the Singapore daily prices for copra, on the Singapore Chamber of Commerce Weekly Reports for the month and on other local sources of information. Palm oil reports and certain coffee prices are kindly supplied by Guthrie & Co. Ltd., Kuala Lumpur, local palm oil prices by Whittall & Co., Kuala Lumpur, the Singapore prices of imported coffee and arecanuts by Lianqui Trading Company of Singapore, and Singapore derris prices by Hooglandt & Co., Singapore.

1 picul = 133 1/3 lbs. The dollar is fixed at two shillings and four pence.

Note.—The Department of Agriculture will be pleased to assist planters in finding a market for agricultural produce. Similar assistance is also offered by the Malayan Information Agency, 57, Trafalgar Square, London, W.C.2.

MALAYAN AGRICULTURAL EXPORTS, DECEMBER, 1939.

PRODUCT	Net Exports in Tons			
	Year 1938	Year 1939	December 1938	December 1939
Arecanuts ...	33,769	38,489	2,370	2,050
Coconuts fresh†‡ ...	116,743†	97,275†	14,924†	6,831†
Coconut oil‡ ...	49,140	61,360	5,108	5,096
Copra‡ ...	68,754	34,420	4,164	8,971*
Copra cake ...	7,112	10,707	626	254
Gambier, all kinds ...	1,632	1,572	113	169
Palm kernels ...	9,359	10,774	939	1,761
Palm oil ...	54,377	59,712	4,511	4,600
Pineapples, canned ...	73,168	65,802	4,500	3,957
Rubber¶ ...	360,898¶	361,484¶	25,240¶	32,755¶
Sago,—flour ...	4,537	9,583	695	1,459
,, —pearl ...	4,203	3,883	250	476
,, —raw ...	5,088*	4,435*	263*	190*
Tapioca,—flake ...	981	1,068	84	129
,, —flour ...	3,072*	2,706*	229*	773*
,, —pearl ...	17,818	18,277	1,324	831
Derris ...	676	1,356	88	149
‡Copra equivalent ...	150,944	136,075	12,762	553*

† hundreds in number. * net imports. ¶ production.

MALAYAN PRODUCTION OF PALM OIL AND KERNELS

(In long tons, as declared by Estates).

Month 1940	Palm Oil			Palm Kernels		
	F.M.S.	U.M.S.	Malaya	F.M.S.	U.M.S.	Malaya
January	2,007.6	2,474.0	4,481.6	434.3	497.0	931.3
January 1939 ...	2,402.5	2,726.3	5,128.8	429.7	502.0	931.7
Total for the year 1939 ...	30,157.7	27,215.0	57,372.7	5,639.3	4,533.1	10,172.4

Stocks on estates as at 31st January, 1940, were : palm oil 2,496 tons, palm kernels 1,613 tons.

State or Territory	Estimated Acreages of Tappable Rubber (9)+(11)	Acreages of tappable rubber not tapped: On estates which have entirely ceased tapping — Acreage	Percentage of (3) to (2)	On estates which have partly ceased tapping (a) — Acreage	Percentage of (5) to (2)	Area of tappable rubber never been tapped (b) — Acreage	Percentage of (7) to (2)	Total area not tapped (3)+(5) (c) — Acreage	Percentage of (9) to (2)	Total area tapped during the month — Average	Percentage of (11) to (2)	Area of tappable rubber rested under rotational systems (c) — Acreage	Percentage of (13) to (2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
S. S.—													
Province Wellesley ...	42,894	114	0.3	9,480	22.1	505	1.2	9,594	22.4	33,300	77.6	8,393	19.6
Malacca ..	116,782	1,869	1.6	19,361	16.6	1,615	1.4	21,230	18.2	95,552	81.8	25,195	21.6
Penang ..	2,549	nil	nil	844	33.1	35	1.4	844	33.1	1,705	66.9	60	2.4
Singapore ..	32,051	4,590	14.3	6,332	19.8	251	0.8	10,922	34.1	21,129	65.9	2,712	8.5
Total S.S. ...	194,276	6,573	3.4	36,017	18.5	2,406	1.2	42,590	21.9	151,686	78.1	36,360	18.7
F. M. S.—													
Perak ...	283,299	6,451	2.3	38,226	13.5	6,494	2.3	44,677	15.8	238,622	84.2	41,190	14.5
Selangor ...	314,945	3,681	1.2	33,065	10.5	5,656	1.8	36,746	11.7	278,199	88.3	47,935	15.2
Negri Sembilan ...	260,209	5,860	2.2	44,449	17.1	9,457	3.6	50,309	19.3	209,900	80.7	36,719	14.1
Pahang ...	85,755	1,798	2.1	14,725	17.2	4,635	5.4	16,523	19.3	69,232	80.7	7,916	9.2
Total F.M.S. ...	944,208	17,790	1.9	130,465	13.8	26,242	2.8	148,255	15.7	795,953	84.3	133,760	14.2
U. M. S.—													
Johore ...	476,958	7,533	1.6	88,533	18.5	32,425	6.8	96,066	20.1	380,892	79.9	56,411	11.8
Kedah ...	198,542	7,737	3.9	20,599	10.4	5,907	3.0	28,336	14.3	170,206	85.7	40,183	20.2
Kelantan ...	31,257	403	1.3	5,179	16.6	1,782	5.7	5,582	17.9	25,675	82.1	5,384	17.2
Trengganu (d) ...	4,817	nil	nil	40	0.8	nil	nil	40	0.8	4,777	99.2	1,500	31.1
Perlis (e) ...	1,459	243	16.7	253	17.3	144	9.9	496	34.0	963	66.0	154	10.6
Brunei ...	5,971	nil	nil	1,161	19.4	270	4.5	1,161	19.4	4,810	80.6	1,141	19.1
Total U.M.S. ...	719,004	15,916	2.2	115,765	16.1	40,528	5.6	131,681	18.3	587,323	81.7	104,773	14.6
Total Malaya ...	1,857,488	40,279	2.2	282,247	15.2	69,176	3.7	322,526	17.4	1,534,962	82.6	274,893	14.8

Notes.—(*a*) Area out-of-tapping on estates which have partly ceased tapping refers to areas definitely being rested and excludes areas on any tapping round.

(*b*) The acreage shown in column (7) is included in columns (3) and (5).

(*c*) Areas of tappable rubber rested under rotational systems are not considered as out-of-tapping and therefore columns (11) and (12) include columns (13) and (14) respectively.

(*d*) Registered companies only.

(*e*) Figures for the quarter ending 31st December, 1939.

MALAYAN RUBBER STATISTICS Table I.

Acreage, Stocks, Production, Imports and Exports of Rubber, including Latex, Concentrated Latex and Revertex.

FOR THE MONTH OF JANUARY, 1940, IN DRY TONS.

State or Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports				Exports including re-exports				Stocks at end of month			Consumption 3	
								during the month		January 1940		during the month		January 1940						
	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. 1940	during the month	Jan. 1940	Foreign	From Malay States & Labuan	Foreign	From Malay States & Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. 1940
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
MALAY STATES :—																				
Federated Malay States ...	...	3,252	26,922	15,440	15,440	13,777	13,777	Nil	Nil	Nil	Nil	14,456	11,804	14,456	11,804	...	7,519	25,588	24	24
Johore ...	...	1,279	9,711	7,000	7,000	9,043	9,043	Nil	97	Nil	97	3,786	11,019	3,786	11,019	...	3,049	9,276	...	...
Kedah ...	...	579	6,224	3,974	3,974	1,846	1,846	Nil	Nil	Nil	Nil	2,008	4,005	2,008	4,005	...	382	6,228	...	...
Perlis ...	...	11	53	21	21	46	46	Nil	Nil	Nil	Nil	Nil	66	Nil	66	...	25	40	...	...
Kelantan ...	...	173	830	446	446	1,321	1,321	Nil	Nil	Nil	Nil	62	1,653	62	1,653	...	372	683	...	...
Trengganu ...	...	Nil	318	211	211	448	448	Nil	Nil	Nil	Nil	Nil	617	Nil	617	...	91	269	...	...
Brunei ...	...	Nil	80	72	72	81	81	...	...	...	...	...	157	...	157	...	11	65	...	...
Total Malay States	...	5,294	44,138	27,164	27,164	26,562	26,562	Nil	97	Nil	97	20,312	29,321	20,312	29,321	...	11,449	42,149	24	24
S. SETTLEMENTS :—																				
Malacca ...	...	1,304	2,389	1,451	1,451	1,169	1,169	Nil		Nil		3,004		3,004		...	2,181	2,257	...	...
Province Wellesley	...	227	1,191	612	612	338	338	Nil		Nil		8,478		8,478		...	923	1,200	...	...
Penang ...	1,499	1,602	14	23	23	117	117	4,129	24,226	4,129	24,226		Nil		Nil	2,733	3,777	19	...	...
Singapore ...	5,147	7,098	288	194	194	36	36	25,946		25,946		24,420		24,420		10,088	19,376	288	23	23
Labuan ...	...	23	Nil	Nil	Nil	14	14	66		66		Nil		Nil		...	38	Nil	...	...
Total Straits Settlements ...	6,646	10,254	3,882	2,280	2,280	1,674	1,674	30,141	24,226	30,141	24,226	35,902	Nil	35,902	Nil	12,821	26,295	3,764	23	23
Total Malaya ...	6,646	15,548	48,020	29,444	29,444	28,236	28,236	30,141	24,323	30,141	24,323	56,214	29,321	56,214	29,321	12,821	37,744	45,913	47	47

TABLE II
DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
22	23	24	25	26	27	28
DRY RUBBER	6,517	18,228	3,575	2,861	2,303	260
WET RUBBER	1,002	1,148	202	292	746	122
TOTAL ...	7,519	19,376	3,777	3,153	3,049	382

TABLE III
FOREIGN EXPORTS

PORTS 29	For month 30	Jan. 1940 31
Singapore ...	37,805	37,805
Penang ...	12,304	12,304
Port Swettenham.	5,782	5,782
Malacca ...	323	323
MALAYA ...	56,214	56,214

TABLE IV
DOMESTIC EXPORTS 4

AREA 32	For month 33	Jan. 1940 34
Malay States ...	49,542	49,542
Straits Settlements	3,774	3,774
MALAYA ...	53,316	53,316

Notes:—

1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained.
2. The production of estates of less than 100 acres is estimated from the formula: Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month. + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + [20] − [2] − [3] − [4] − [5] − [9] − [10]. For the Straits Settlements the production of estates of less than 100 acres is represented by sales or exports as shown by cess paid.
3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15% wet sheet, 25% scrap, lump, etc., 40%; stocks elsewhere are in dry weights as reported by the dealers themselves.
4. Columns (33) and (34) represent exports of rubber subject to regulation which, for Singapore and Penang Islands are represented by sales or exports as shown by cess paid.
5. All statements are brought up to date monthly, and any inaccuracies that may be disclosed are corrected in the totals; the latest publication

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1940.

Locality.	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine.		
	Means of			Absolute Extremes						Total.		Most in a day.	Number of days.					Total.	Daily Mean.	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in or more	Precipitation, .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.						hrs.	hrs.	
Kuala Lumpur Aerodrome Selangor ...	90.3	71.5	80.9	94	66	86	75	83.9	85.2	5.80	147.3	2.31	14	12	3	2	—	192.25	6.20	52
Port Swettenham Aerodrome, Selangor ...	87.8	70.3	79.1	92	66	83	74	85.0	85.2	5.88	149.4	1.41	12	10	1	1	—	200.40	6.46	54
Sitiawan, Perak ...	88.3	71.5	79.9	90	68	85	74	83.2	84.2	2.94	74.7	1.02	11	8	1	—	—	229.75	7.41	63
Ipoh Aerodrome, Perak ...	90.6	70.8	80.7	94	67	88	74	83.0	84.1	8.26	209.8	1.99	12	10	3	—	—	253.80	8.19	69
Temerloh, Pahang ...	87.0	71.0	79.0	91	67	83	74	83.9	84.9	2.82	71.6	1.76	12	7	1	5	—	202.60	6.53	55
Kuala Lipis, Pahang ...	85.8	70.3	78.1	89	67	82	73	81.8	83.1	5.38	136.7	1.04	17	13	1	22	—	176.60	5.70	48
Kuala Pahang, Pahang ...	82.7	74.5	78.6	84	72	80	77	82.2	83.7	3.82	97.0	1.60	18	11	—	—	—	196.00	6.32	53
Kallang Aerodrome, S'pore ...	86.4	73.9	80.1	90	71	81	76	80.5	81.9	3.40	86.4	1.43	12	9	1	—	1	177.30	5.72	47
Bayan Lepas Aerodrome Penang ...	87.8	72.8	80.3	90	69	85	76	82.7	83.8	2.33	59.2	0.40	9	9	—	—	—	275.70	8.89	75
Malacca Town, Malacca ...	87.1	72.8	79.9	92	71	83	75	83.3	83.8	0.64	16.3	0.32	6	6	—	—	4	205.50	6.63	55
Kluang, Johore ...	86.0	70.9	78.5	91	68	82	73	79.3	80.7	2.06	52.3	0.55	9	7	—	1	—	179.95	5.80	48
Mersing, Johore ...	81.8	74.3	78.1	84	71	78	76	78.7	79.9	10.72	272.3	4.82	15	11	—	—	1	198.10	6.39	53
Alor Star, Kedah ...	89.7	69.2	79.5	93	66	87	74	82.6	83.8	0.75	19.1	0.75	1	1	—	1	—	286.35	9.24	78
Kota Bahru, Kelantan ...	83.8	69.8	76.8	87	66	80	73	80.0	81.9	2.06	52.3	0.89	10	8	—	1	—	199.20	6.43	54
Kuala Trengganu, Trengganu	82.5	70.6	76.5	87	67	76	74	79.8	81.4	2.39	60.7	0.85	12	8	—	4	—	194.63	6.28	53
Labuan ...	84.0	76.0	80.0	89	71	79	79	83.8	84.7	5.15	130.8	2.83	13	8	1	—	—	185.70	5.99	50
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	68.8	59.7	64.3	75	56	64	63	69.4	70.0	6.00	152.4	0.91	22	19	—	20	—	126.90	4.09	34
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	70.7	53.9	62.3	73	42	66	60	68.5	69.3	4.98	126.5	1.94	12	10	—	3	—	160.60	5.18	43
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	70.5	57.2	63.9	75	54	66	59	*	*	4.73	120.1	1.59	11	9	—	—	—	167.00	5.39	45

* Not recorded.